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January 30, 1961

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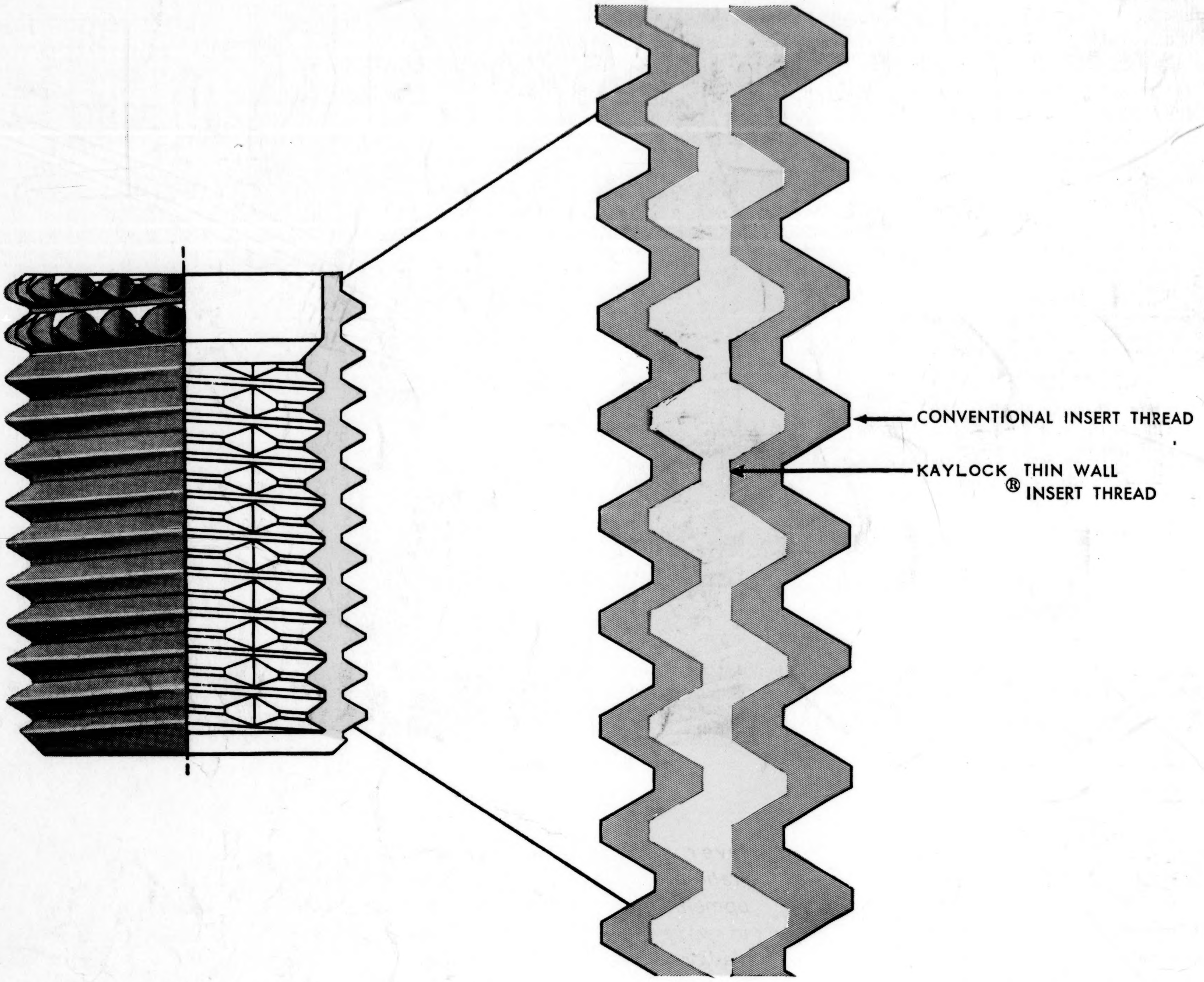

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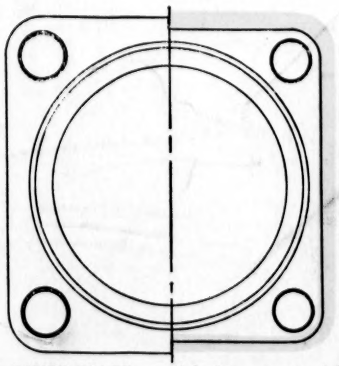

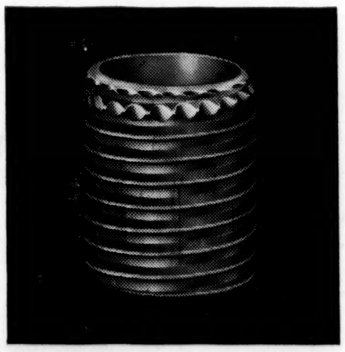

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AVIATION CALENDAR

Feb. 14-16—Second Annual Symposium on Non-destructive Testing of Aircraft and Missile Components (unclassified), Society for Non-destructive Testing and Southwest Research Institute, Gunter Hotel, San Antonio, Tex.
Feb. 15-17—International Solid-State Circuits Conference, Institute of Radio Engineers, Sheraton Hotel, Philadelphia.
Feb. 16-17—Symposium on Recent Developments in Materials for Nuclear Applications, University of New Mexico, Albuquerque, N. M.
Feb. 26-28—Texas Agricultural Aviation Conference, Texas A & M College, College Station, Tex.
Mar. 5-9—Sixth Annual Gas Turbine Conference and Exhibit, American Society of Mechanical Engineers, Shoreham Hotel, Washington, D. C.
Mar. 9-10—Second Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, Philadelphia.
Mar. 9-10—Flight Propulsion Meeting, Institute of the Aeronautical Sciences, Cleveland, Ohio (classified).
Mar. 12-16—Aviation Conference, American Society of Mechanical Engineers, Statler-Hilton, Los Angeles, Calif.
Mar. 13-16—Missile and Space Vehicle Testing Conference, American Rocket Society, Biltmore Hotel, Los Angeles, Calif.
Mar. 16-18—Fifth National Conference on Aviation/Space Education, Mayflower Hotel, Washington, D. C.
Mar. 20-23—International Convention, Institute of Radio Engineers, Coliseum and Waldorf Astoria Hotel, New York, N. Y.
Mar. 20-24—1961 Western Metal Exposi-

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AVIATION WEEK and Space Technology
January 30, 1961
Vol. 74, No. 5

Published weekly with an additional issue in December by McGraw-Hill Publishing Company, James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. **Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Printed at Albany, N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator. OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

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Single copies 75¢. Subscription rates—United States and possessions, $7 one year. Canada $8 one year. All other countries, $20 one year.

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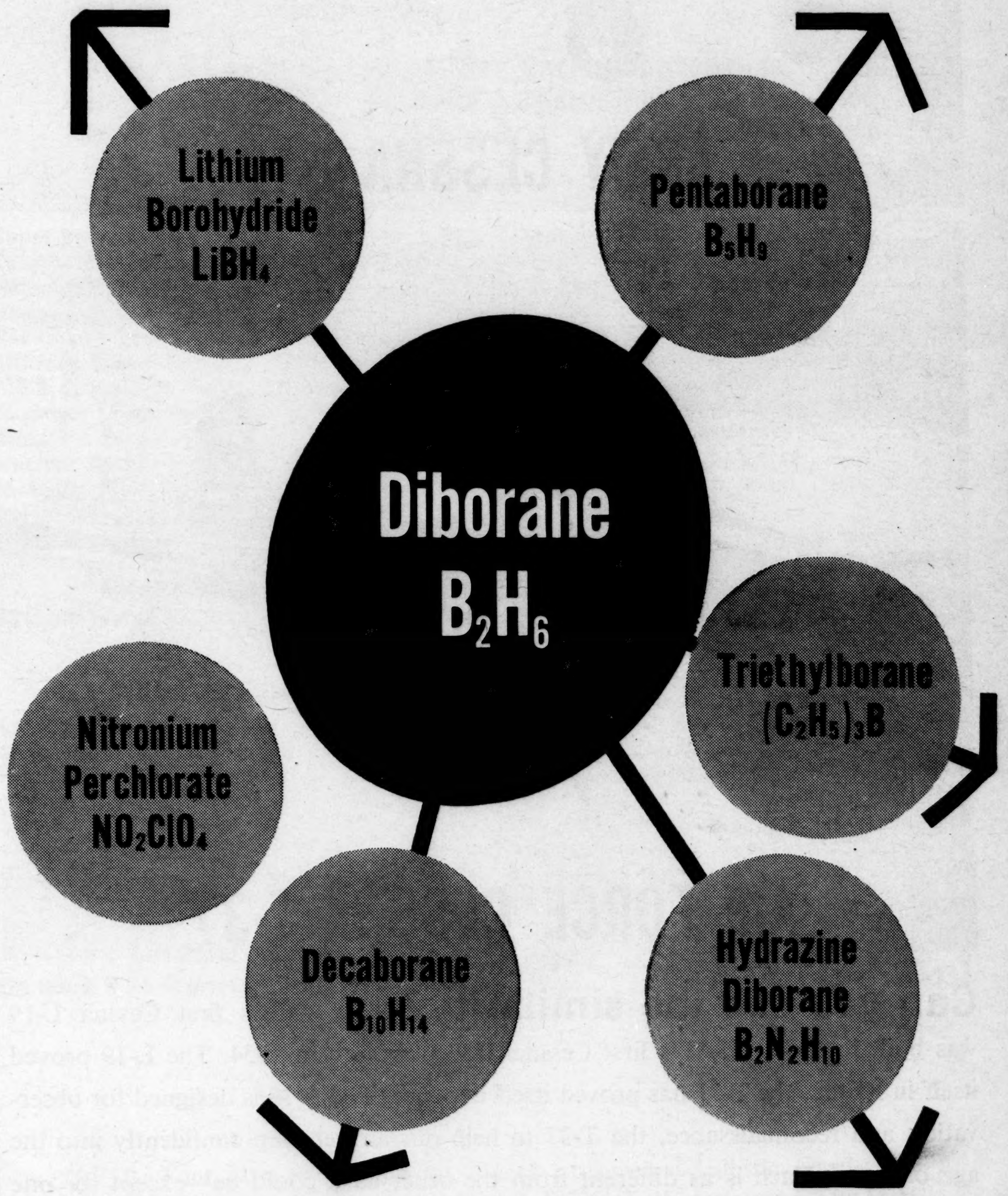
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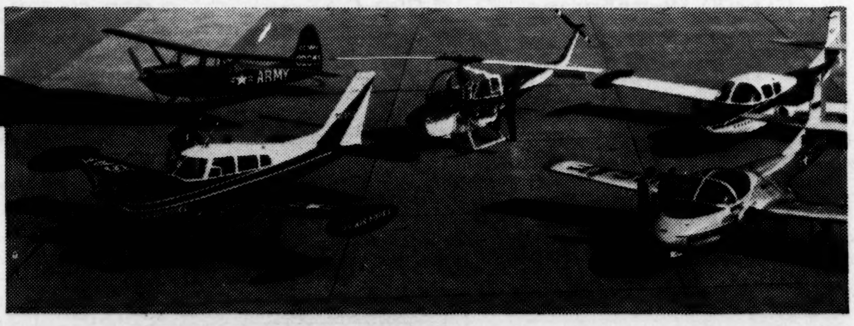

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tion, American Society for Metals, Pan-Pacific Auditorium, Los Angeles, Calif.

Mar. 27-31—1961 Symposium on Temperature, Its Measurement and Control in Science and Industry, Columbus, Ohio. For information: V. W. Sikora, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Mar. 28-29—Nucleonics in Flight Symposium, American Nuclear Society, Statler-Hilton Hotel, Dallas, Tex.

Apr. 4-5—Aviation Technician School Administrators Conference, Purdue University, Lafayette, Ind.

Apr. 4-6—International Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Apr. 4-6—Lifting Re-entry Vehicles: Structures, Materials & Design, American Rocket Society, Palm Springs, Calif.

Apr. 4-7—National Aeronautic Meeting, Society of Automotive Engineers, Commodore Hotel, New York, N. Y.

Apr. 10-11—Spring Meeting, Western States Section/The Combustion Institute, Aeronutronic Division of Ford Motor Co., Newport Beach, Calif.

Apr. 13-14—Institute of the Aerospace Sciences/Army Aviation Meeting (classified), Washington, D. C.

Apr. 17-28—14th Technical Conference, International Air Transport Assn., Queen Elizabeth Hotel, Montreal, Canada.

Apr. 18-20—Symposium on Chemical Reactions in the Lower and Upper Atmosphere, Stanford Research Institute, Mark Hopkins Hotel, San Francisco, Calif.

Apr. 20-22—General Meeting, American Meteorological Society with the American Geophysical Union, Washington, D. C.

Apr. 22-25—Annual Business Meeting and Conference, American Assn. of Airport Executives, Broadmoor Hotel, Colorado Springs, Colo.

Apr. 26-28—Liquid Rockets, Propellants and Combustion Conference, American Rocket Society, Palm Beach Biltmore, Palm Beach, Fla.

Apr. 30-May 4—Seventh National Aero-Space Instrumentation Symposium, Instrument Society of America, Adolphus Hotel, Houston, Tex.

May 8-10—National Aeronautical Electronics Conference, IRE, Miami and Biltmore Hotels, Dayton, Ohio.

May 9-11—Western Joint Computer Conference and Exhibit, Ambassador Hotel, Los Angeles, Calif.

May 12-14—Mid-American Air Fair, Municipal Airport, Wichita, Kan.

May 15-17—National Symposium on Microwave Theory and Techniques, IRE, Sheraton Park Hotel, Washington, D. C.

May 15-18—20th Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton Hotel, Akron, Ohio.

May 22-24—National Telemetering Conference, Sheraton-Towers Hotel, Chicago, Ill.

May 22-24—Fifth National Symposium on Global Communications, Institute of Radio Engineers, Hotel Sherman, Chicago.

May 26-June 4—24th French International Air Show, Le Bourget, Paris, France.

Sept. 4-10—1961 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Aviation Week and Space Technology

January 30, 1961

Vol. 74, No. 5
Member ABP and ABC

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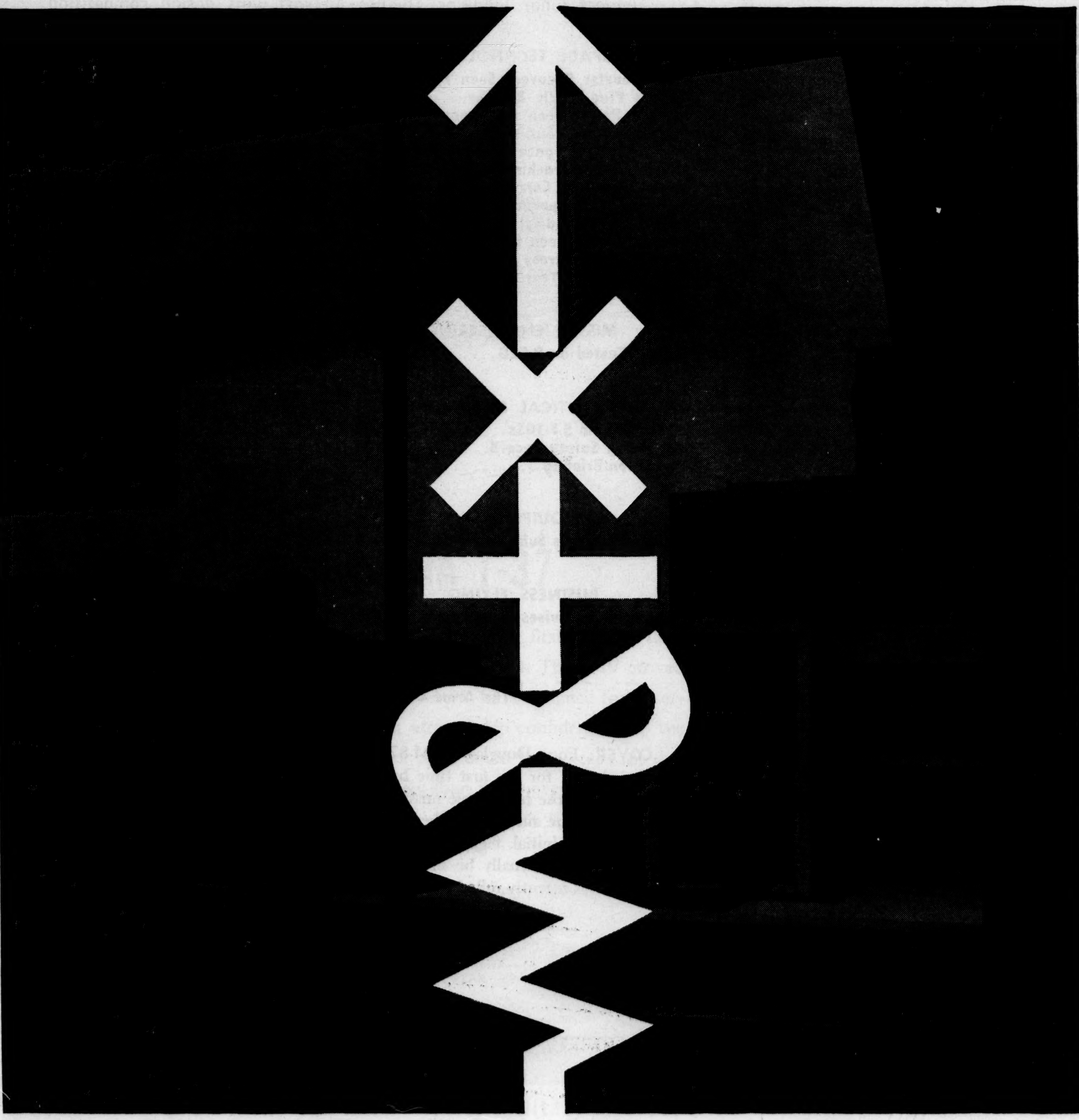


EDITORIAL

The Arms Control Problem

It is evident from the early days of President Kennedy's Administration that this country is going to make another attempt to come to grips with the problem of international arms control. This is an area in which our spokesmen and negotiators have been ill-prepared during the past few years of the Soviet Union's propaganda offensive on the "disarmament" theme. As a result, in many countries of the world lying between the United States and the Sino-Soviet bloc, the psychological advantages of advocating "disarmament and peace" have accrued to the Communist cause while the onus for opposing such universally desired objectives has fallen on the U. S. It was probably a belated realization of this fact that prompted President Eisenhower to lash out again at his final press conference at the general circulation magazine advertising that featured missiles and military equipment and, he claimed, gave the impression that the munitions business is the main occupation of this nation.

One of the reasons the Soviets have been able to make such substantial propaganda gains from the "disarmament" issue—while actually pursuing a policy of fomenting international friction by supplying arms to Algeria, the United Arab Republic, a half dozen new African republics, Cuba, and Indo-China—is that the U. S. approaches to the problems of arms control have been primarily on a lofty moralistic plane without any real understanding of the technical and diplomatic problems involved.

The Eisenhower "open skies" policy and other efforts along this line were hastily tossed together gimmicks aimed at a quick headline impact rather than at any real, long-term gains in the diplomatic chess game.

What is badly needed now is a thorough study of this arms control chessboard and all the possible moves to formulate an effective policy that hopefully can achieve a measure of international arms control without handing the Soviet bloc priceless opportunity for achieving a significant military and political advantage.

There is little doubt that the Soviet Union wants some type of relief from the economic burden of continuing its attempts to match or surpass our galloping technology in the weapons field. While this burden is not yet any serious threat to the rest of the U. S. economy, there is ample evidence that the Soviets are seriously straining their own economy to maintain their current pace.

It is also evident that the Soviets are not about to offer any substantial gambit in an arms control agreement unless they can see major advantages accruing to their international position as a result. For example, the Soviets now value their internal secrecy on military preparations and dispositions very highly despite some successful efforts of the U. S. to penetrate this veil. It is noteworthy that one of the big items not exposed by the U-2 flights was the location of Soviet IRBM and ICBM bases other than the experimental test operations at Krasny Yar and Tyura Tam. The missile installations photographed by the U-2 flights and other methods were defensive ground-to-air sites of the older familiar chevron shapes and the newer dome-shaped "House of David" installations.

Although the influx of foreign tourists into the Soviet Union has been widely publicized during the past few years, it is not generally realized that these tourists tread an extremely narrow path through a few "authorized cities," most of them resorts, and that the vast majority of European Russia and Siberia is still forbidden territory to any foreigner. For example, the Soviets refused to allow the U. S. civil aviation technical mission to visit a single jet engine overhaul center of Aeroflot, although a comparable Soviet delegation visited similar facilities in this country on their visit. Andrei Tupolev and other Soviet aviation technicians visited U. S. military aircraft factories in 1959 but Vice President Nixon was denied a look at similar installations during his Soviet tour in the same year.

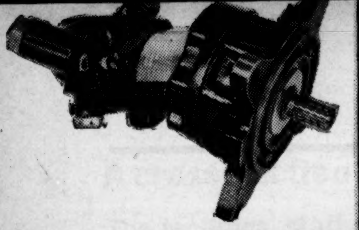
This highly-prized Soviet secrecy serves a dual purpose in screening both the strength and the critical weakness of Soviet power. It would be impossible to maintain anything approaching this degree of secrecy in anything but a tightly policed autocracy. But we cannot realistically expect the Soviets to give up this asset in an agreement for mutual arms inspection without achieving some substantial goal of their own in exchange.

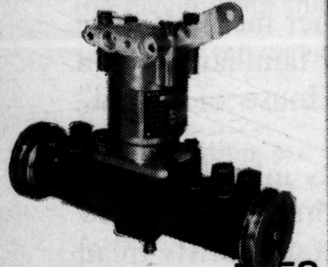
It is also true that while an on-the-spot inspection of Soviet arms might add considerable knowledge to the world's understanding of their real position, it would not offer a positive, foolproof method of detecting and preventing a surprise attack by nuclear-armed ICBMs. The 30-min. time span between the launch of an ICBM and its impact on an enemy target with a multi-megaton warhead will continue to defy any communications or reconnaissance system now in operation.

Rather than any dramatic beating of the world's swords into ploughshares as Nikita Khrushchev proposed to the United Nations, we can expect a period of tough diplomatic haggling over initial approaches to the basic problems of international arms control. With the increasing spread of nuclear weapon capabilities beyond the U. S., Britain and the Soviet Union, this problem will become more complex and it will be easier for one participant to be outmaneuvered significantly through diplomatic or technical ignorance. A good example of this has been the U. S. ban on nuclear testing without any real assurance that the Soviets are following a similar policy, despite their public assurances that they are.

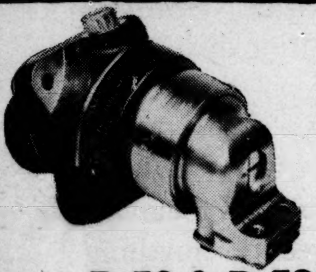
The arms control game will require the very best technical and diplomatic players the U. S. can put onto the field. The prospects for any substantial success in achieving an effective international control of nuclear weapons appears dim, but the penalty for failure to put forth this nation's very best effort in this area may be cataclysmic.

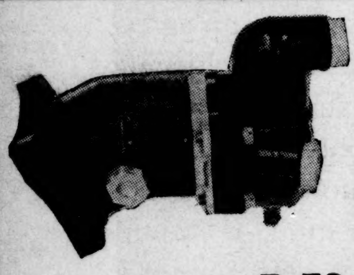
—Robert Hotz

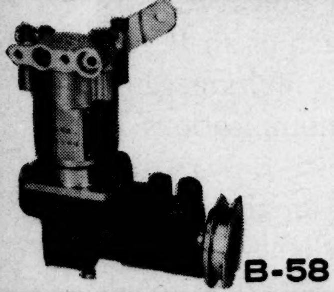


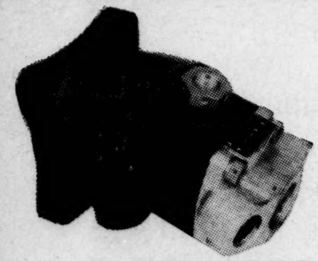


Some of the Units now in Production









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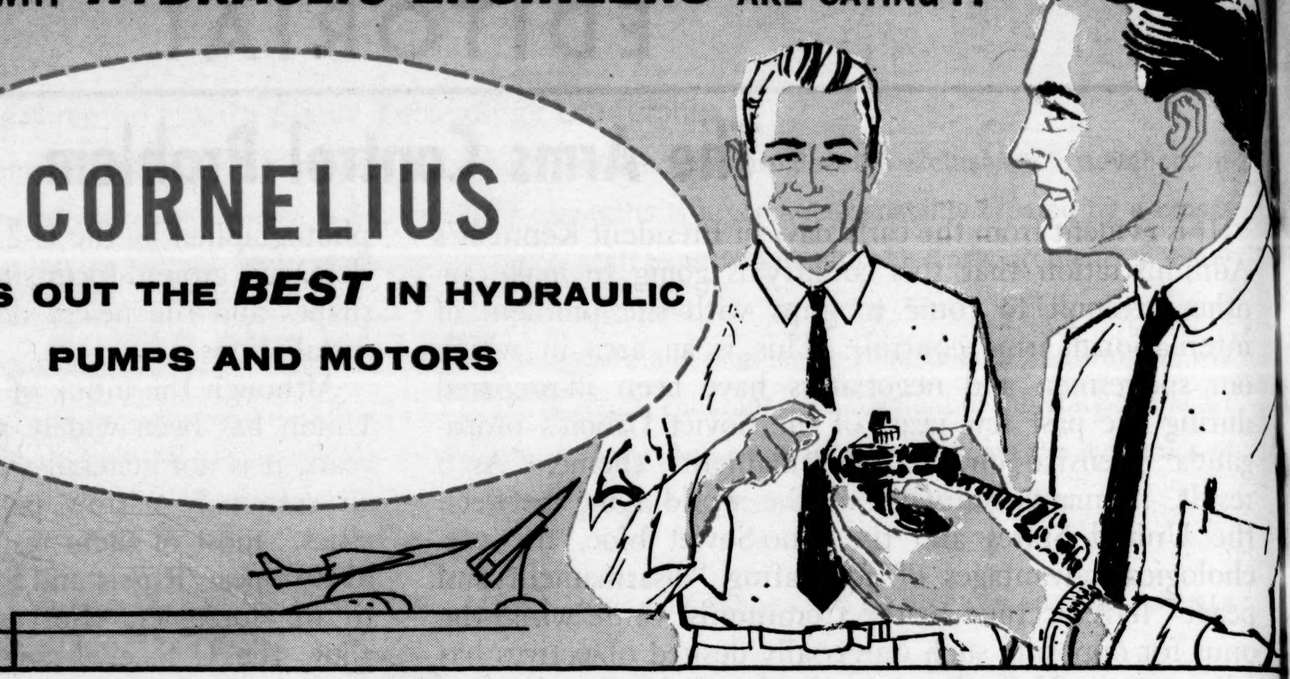

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4	30°	.04	19.1	.26	4.86	16000	23000	1.25
5	13.3°	.05	23.9	.325	4.55	12000	18000	1.75
6	15.7°	.06	28.6	.390	5.45			
7	18.6°	.07	33.4	.455	6.36			
8	21.4°	.08	38.2	.519	7.26			
9	24.12°	.09	43.0	.584	8.16			
10	27°	.10	47.7	.650	9.10			
11	30°	.11	52.5	.714	9.99			
12	23.5°	.125	60.0	.812	10.2	10800	16000	2.1
16	30°	.160	76.5	1.04	13.1			
20	23.5°	.200	95.5	1.30	14.5	9600	13800	3.0
25	30°	.250	120	1.62	18.1			
32	23.5°	.320	153	2.08	20.2	8400	11900	4.2
40	30°	.400	191	2.60	25.4			
50	23.5°	.500	239	3.25	26.9	7100	10200	6.6
64	30°	.640	306	4.16	34.5			
80	23.5°	.800	382	5.20	37.6	6200	8800	9.0
100	30°	1.000	478	6.50	47.0			
125	23.5°	1.250	600	8.12	53.0	5600	7600	12.0
160	30°	1.600	765	10.40	67.9			
200	23.5°	2.000	955	13.00	75.8	5000	6600	16.3
250	30°	2.500	1200	16.20	94.5			
320	23.5°	3.200	1530	20.80	99.5	4100	5300	23.5
400	30°	4.000	1910	26.00	124.0			

We call this new hydraulic design **high energy/low friction** because it delivers 92 to 93% efficiency at optimum speeds and pressures. All units are designed to meet MIL. P-19692 (AER), MIL. P-7858, MIL. M-7997-A, MIL. P-5954 and MIL. P-5994. Cornelius units are qualified for use in Type III (350° F.) Oronite, as well as Type II MIL-5606 (275° F.) and Type I (160° F.) Skydrol systems. Cornelius pumps and motors are used on B-52, B-58 and 707 aircraft. Other models are used for Pershing missile ground support operations and a new Cornelius designed, packaged hydraulic system for Air Force cargo winches.

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WHO'S WHERE

In the Front Office

Joseph Roos, president of Air France, succeeding **Max Hymans**, who is retiring for reasons of health. Air France has elected Mr. Hymans as honorary president.

Homer R. Denius, board chairman, Radiation, Inc., Melbourne, Fla. Mr. Denius continues as president.

Henry Feldman, board chairman, has resumed the presidency of FXR, Inc., Woodside, N. Y., succeeding **Tore N. Anderson**, resigned, who will form his own microwave consulting business.

Curtis A. Haines, vice president-product and facilities planning, Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc., Waltham, Mass. Also: **Edward W. Doty**, manager-product development organization.

Myron Roebuck, vice president in charge of the newly established western operation (Van Nuys, Calif.) of Dynatronics, Inc., Orlando, Fla.

Neil L. Hanson, vice president-marketing, Permanent Filter Corp., Los Angeles, Calif.

Richard S. Cesaro, vice president-corporate planning, research and development, Autometric Corp., New York, N. Y.

Dr. George F. Floyd, vice president-systems research, Bissett-Berman Corp., Los Angeles, Calif.

Glen McDaniel, senior vice president, Litton Industries, Inc., Beverly Hills, Calif.

L. S. Thees, division vice president-general sales, RCA Electron Tube Division, Radio Corporation of America, Harrison, N. J.

Maj. Gen. Charles F. Born (USAF, ret.), vice president and a director, Ken R. White Consulting Engineers, Inc., Denver, Colo.

Harry T. Brierley, vice president-sales of aircraft guidance systems and missile components, Astrex, Inc., New York, N. Y.

Walter H. Powell, vice president-operations, International Resistance Co., Philadelphia, Pa.

P. J. Fritch, controller, Rocketdyne Division of North American Aviation, Inc., Canoga Park, Calif.

A. Howard Hasbrook, chief, Crash Safety Section, Federal Aviation Agency's Civil Aeromedical Research Institute, Norman, Okla.

Brig. Gen. Joseph E. Gill, assistant for site activation, Air Materiel Command's Ballistic Missiles Center, Inglewood, Calif., with staff surveillance over all management phases of all ballistic missile sites. Also: **Col. John L. Zoeckler**, director of ballistic missiles; **Col. Henry H. Harlow**, chief of staff of BMC.

Honors and Elections

Dr. Frank T. McClure, chairman of the Research Center at Johns Hopkins University Applied Physics Laboratory, has received the first award made under the invention award authority of the Space Act for his invention of a Satellite Doppler Navigation System which became the basis of the Navy Department's navigational satellite program, Project Transit.

(Continued on page 121)

INDUSTRY OBSERVER

▶ Wright Air Development Division is expected to award a Project Slam study contract within the next two months to one of the three companies—Chance Vought, Convair and North American—competing in the nuclear-powered supersonic low-altitude missile project. Study will help WADD formulate technical concepts for the program. Work is continuing on Project Pluto, which would produce the ramjet engine for Slam (AW Jan. 16, p. 74).

▶ Several study contracts for Jet Propulsion Laboratory's Prospector lunar mobile-vehicle project are to be awarded between May and September. Prime contractor will subsequently be chosen from among the study contractors, following a pattern set with Project Surveyor (see p. 50).

▶ Navy's proposed development of the ship-launched Sea Scout satellite booster to provide flexibility in choosing launch sites has been vetoed by the Office of Defense Research and Engineering. Solid fuel Sea Scout would have used the two Polaris missile stages plus two upper stages from the Air Force Blue Scout vehicle (AW Jan. 2, p. 41).

▶ National Aeronautics and Space Administration is expected to order development of a second solar phenomena satellite, S-16A. Ball Bros. Research Corp. is developing S-16, the first satellite of this type, and it is to be launched in April. The S-16A shot is tentatively scheduled for February, 1962.

▶ Martin will build a 35-ft. diameter lunar housing simulator at its Denver facility. The simulator is to be in operation this year and will permit duplication of lunar base living conditions, including a closed ecological system for humans, animals and plants. Power will be provided by solar or nuclear systems.

▶ Advanced Research Projects Agency has contracted with Arinc Research Corp. to study the reliability of existing and planned military satellite payloads with the objective of developing techniques for predicting payload lifetimes.

▶ Cessna's new twin-boom, tractor-pusher business aircraft probably will begin its flight test program late next month (AW Dec. 12, p. 134).

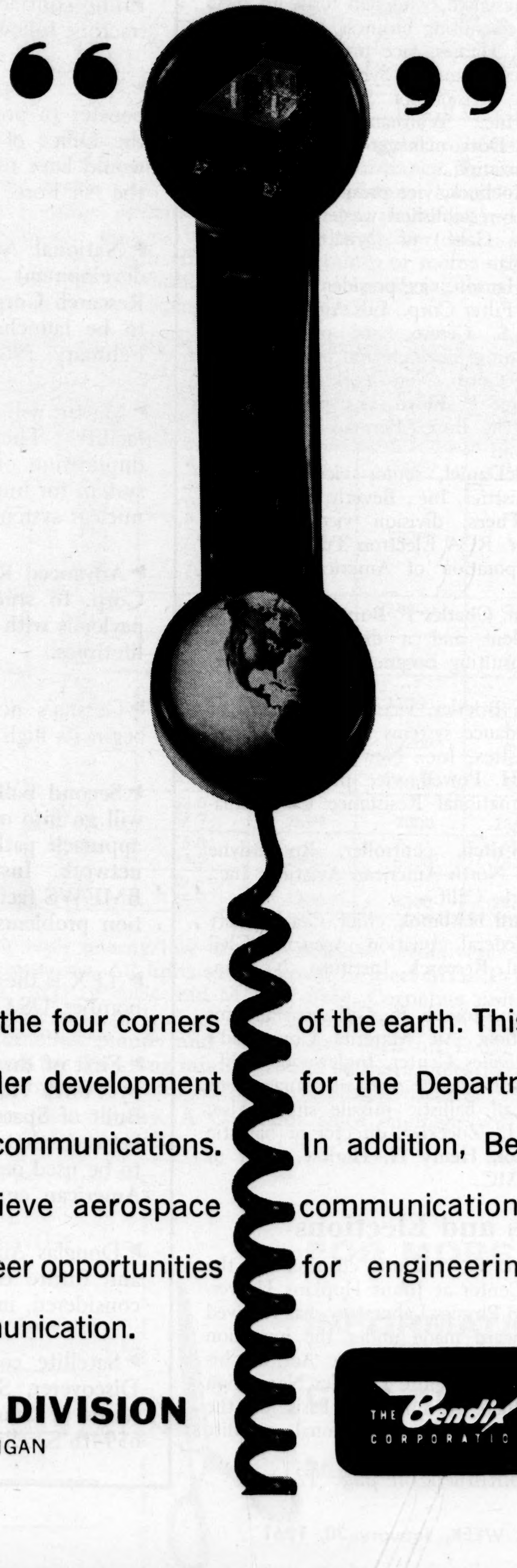
▶ Second Ballistic Missile Early Warning System station, at Clear, Alaska, will go into operation this summer, covering the western and polar ICBM approach paths and closing a large gap in the U. S. early warning radar network. Installation in Britain of the last of the three presently programed BMEWS facilities is moving more slowly than planned because of construction problems.

▶ TFX is the new designation for Weapon System 324A, the STOL fighter-bomber USAF wants to develop for Tactical Air Command.

▶ First of three Saturn C-1 interstage structural fairings has been delivered by North American Aviation's Space and Information Systems Division. Built of Spacemetal, a welded all-steel sandwich structure, the fairing goes between the vehicle's first and second stages. Spacemetal also is expected to be used on the Saturn skirt to reduce rocket engine heat effects. North American currently is negotiating for Saturn C-2 fairing contract.

▶ Douglas Aircraft Co. is conducting an extensive analysis of the present and future U. S. light aircraft market. Various aircraft types are being considered, including at least one developed in Europe.

▶ Satellite control center, initially scheduled to monitor functioning of Discoverer, Samos and Midas vehicles in orbit, is ready for operational status at Sunnyvale, Calif., under joint management of the Air Force's 6594th Satellite Test Wing and Lockheed Missiles and Space Division.



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Washington Roundup

Space Debate

Controversy over the future complexion of the entire national space program has been the cause of delay in selecting a man to head the National Aeronautics and Space Administration. President Kennedy hoped to name a NASA chief late last week (see p. 30).

Man-in-space has been one of the key areas under debate, with the whole question of how far man should go into space being reviewed again. Other controversial issues have been the responsibility for development of boosters and development and operation of communications satellites.

Manned space flight attempts that would follow Mercury were in jeopardy until the Eisenhower Administration left office because the President himself saw no need for any program beyond Mercury. The Budget Bureau cut NASA's Fiscal 1961 budget request for Mercury follow-on research from $23 million to $1 million. In the budget just submitted to Congress by Eisenhower, the bureau cut the same kind of request from NASA's figure of $35 million plus boosters to $15 million plus boosters. Military items related to manned spaceflight were compared directly with similar items in the NASA budget, and the requests were weighed one against the other.

Three viewpoints were represented in the long discussions over what type of man should head NASA. One favored a man with engineering and administrative experience, another argued for a university scientist and the third insisted that political savvy was a more necessary qualification than either scientific or engineering background.

Institute for Defense Analyses, the university corporation that has heretofore done almost all its work for Defense Department, now is conducting disarmament studies for the State Department.

Targeting Battle

Bitter fight expected over Strategic Air Commander Gen. Thomas S. Power's proposal to reduce Army and Navy billets in the tri-service Strategic Targeting Unit failed to take place at a meeting of the Joint Chiefs of Staff last week.

Navy protested that SAC officers would completely dominate the targeting unit's divisions and branches, that Navy officers would be forced into lower echelons and that Navy would have no representation in intelligence. Navy also has objected to the kind of intelligence used, the target estimates based on it and the priority of weapons to be used. It says Polaris missiles and carrier attack aircraft are 15th and 16th on the weapons priority list.

Navy's staff work was well received and no battle materialized. Earlier, Navy had protested the hurried preparation of the Single Integrated Operations Plan and asked for revision. Gen. Power considered the major work now accomplished and wanted a small staff, operating at Omaha, for the future. As a result of last week's meeting, Navy is now cautiously optimistic.

Object tracked over Russia by an Alaskan radar station Jan. 13 was a relatively short range ballistic missile. Reports that it might be a space vehicle resulted because someone—possibly unnerved by the presence of three Russian missile tracking ships in the Pacific—apparently reached for and released the wrong previously prepared news story.

Operation Hush

The Navy unit accused of operating as a propaganda task force against reorganization has been ordered by Secretary John Connally to stay out of public discussions. The unit, created a year ago to study reorganization, is known as Op-06D and consists of Rear Adm. D. W. Knoll, three other officers and two yeomen. Navy denies it is anything like the much larger Op-23, which then-Capt. Arleigh Burke led in paper warfare against USAF's B-36 in 1949. But anti-reorganization letters originating in Op-06D went out to foreign naval attaches here, and officers in the unit admit they were trying to compete on a small scale with USAF's Long Range Plans office, which actively supports the single-service concept.

Aerospace Corp is under scrutiny by the Government Accounting Office for attempting to expand faster than GAO believes it is capable of, and for subcontracting to Space Technology Laboratories. Aerospace was created specifically to avoid what Congress considered a conflict of interest between STL's role as technical adviser to Air Force Ballistic Missile Division and STL's ownership by Thompson Ramo Wooldridge, which manufactures products used in Air Force missile and space programs.

A great many naval officers, including Vice Adm. W. F. Raborn who developed the Polaris missile, strongly opposed Chief of Naval Operations Arleigh Burke's decision to put Polaris on the nuclear cruiser Long Beach. The Burke camp favored Polaris for many surface ships, but the Long Beach is the only one approved. Opponents cite the $58-million cost of conversion and say a do-it-all monster—carrying Talos, Terrier and Asroc weapons already—is being created.

—Washington Staff

Super-Booster Recovery Seen Feasible

Aerojet-General system may save $349 million on minimum 50-flight program foreseen for next decade.

By Michael Yaffee

New York—Relatively simple hydrogen-balloon recovery concept may cut large, multi-million-pound thrust booster program costs by 38%, saving $349 million on minimum 50-flight programs foreseen for the next decade.

The recovery system, which in many ways is similar to the system that will probably be used with the first recoverable Saturn boosters, makes use of a combination of balloons, parachutes and dive brakes. It was developed by Aerojet-General Corp.'s Spacecraft Division as part of the company's Cosmos proposal for a 6-million-lb. thrust, pressurized liquid hydrogen-liquid oxygen, plug nozzle space booster (AW Feb. 1, p. 16). The system is said to be applicable to all large, liquid propellant launch vehicles.

Operational U. S. programs involving large space vehicles of more than 1-million-lb. thrust during the next decade, according to Aerojet's Clarence A. Lysdale, will be characterized by a relatively small number of total flights with widely diversified missions and payloads.

At this time, Aerojet planners foresee no more than 50-100 large vehicle launchings for this period.

Current efforts on launch vehicle recovery should be concentrated on systems which will yield significant savings for programs of the size envisioned, Lysdale says, and not on systems for much larger programs involving thousands of large vehicle launchings, the requirements for which are not evident at this time.

Accordingly, Lysdale suggests that consideration of inherently recoverable booster systems such as winged, manned vehicles, which may provide significant savings on thousand-launch programs, be postponed until the requirements for these large programs are positively established.

Four Recovery Concepts

For the company's proposed 6-million-lb. thrust Cosmos booster, Aerojet's Spacecraft Division developed four recovery concepts in detail. These four systems were described and compared here last week in a report by Lysdale at the annual meeting of the Institute of Aerospace Sciences.

Most economical of the recovery systems described by Lysdale uses a combination of dive brakes, parachutes and a balloon. It also depends upon the availability of residual hydrogen in the booster in a gaseous state and under high pressure. Thus, for boosters with a propellant feed system different from that of the pressurized LO_2-LH_2 Cosmos, a penalty ranging from 15-20% of booster burnout weight would have to be taken into account in the calculations.

In this system, designed to provide a soft landing on water, a small, reaction-jet, attitude-control system, operating on residual gaseous oxygen, orients the booster in an engine-down attitude with the vehicle axis parallel to the flight path prior to re-entry. Metal dive brakes near the interstage section are deployed during the coast-through-apogee period. The brakes, with a total area of 2,500 sq. ft., supply the necessary stabilizing moments during the early phases of re-entry and increase the booster's drag-to-weight ratio, thereby decreasing aerodynamic heating.

Size and weight of the dive brakes could be reduced by deploying a first-stage ribbon parachute at Mach 1.5.

Terminal Descent

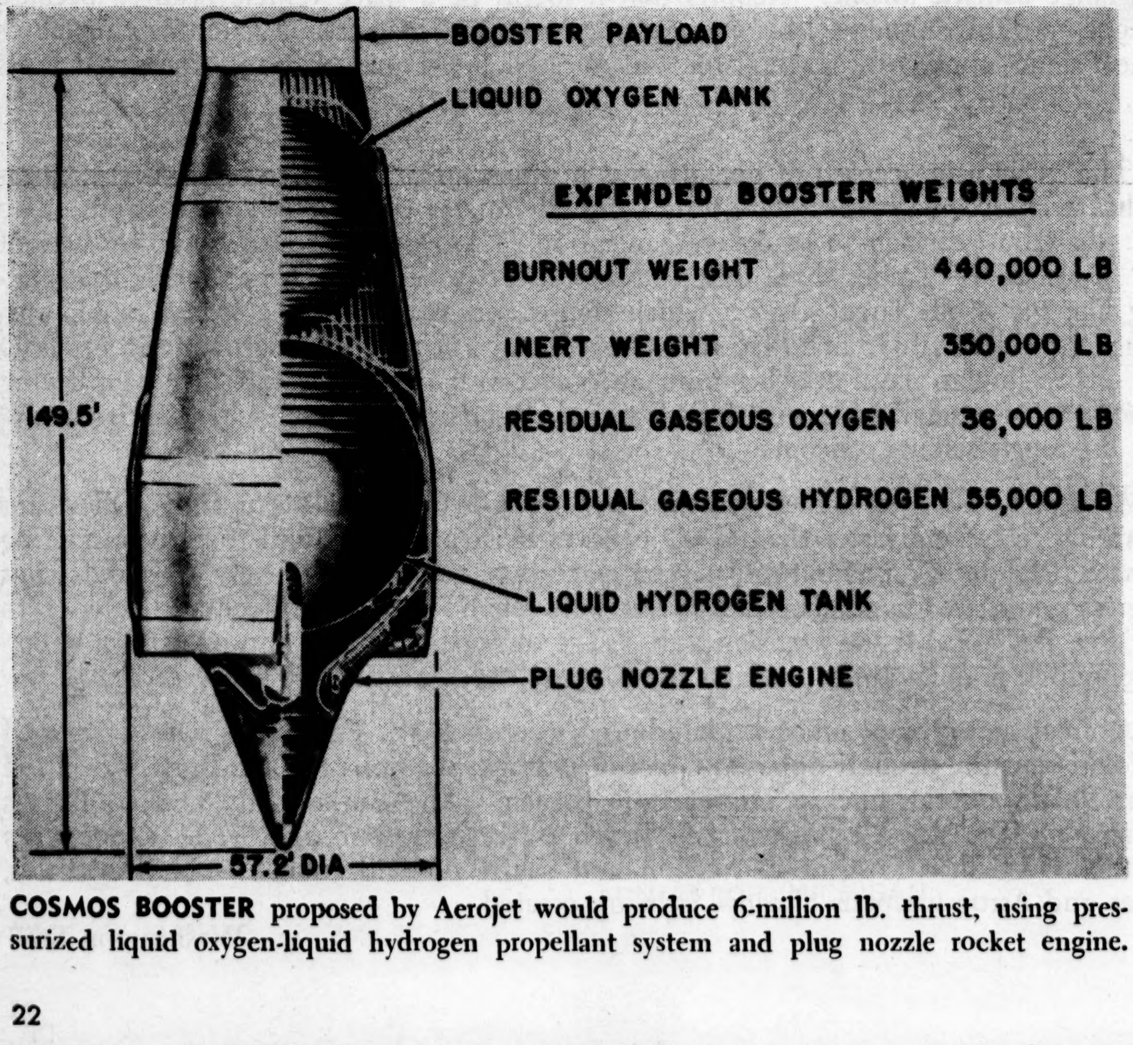
For terminal descent, a cluster of three to five 100-ft. dia. parachutes are deployed at the maximum possible altitude. As soon as the equilibrium dynamic pressure reaches approximately 20 psf., the balloon is deployed, allowing 200-300 sec. for inflation before surface impact. The 55,000 lb. of residual gaseous hydrogen in the Cosmos booster at burnout is adequate to fill a 220-ft. dia. balloon which will support the booster at an equilibrium altitude of 3,000 ft. A high-capacity heat exchanger heats the hydrogen to 60F before it enters the balloon.

At an altitude of 1,000-2,000 ft., the booster and balloon are taken in tow by a surface ship and delivered to a designated location for landing and balloon deflation.

Reasonably good weather conditions are required, says Lysdale, to minimize drift and facilitate retrieval.

A second system described by Lysdale is essentially the same as the previous one except that a number of short duration, solid propellant retrorockets are used in place of the balloon. An equilibrium rate of descent of approximately 100 fps. was chosen in order to obtain the lowest total combined weight of parachutes and retrorockets, After impact, the floating booster would be retrieved by ship.

Rotary wing devices were the basis of a third recovery approach explored by Aerojet engineers. The particular



COSMOS BOOSTER proposed by Aerojet would produce 6-million lb. thrust, using pressurized liquid oxygen-liquid hydrogen propellant system and plug nozzle rocket engine.

rotary wing system for Cosmos was designed to rely primarily on autorotation with some tip-rocket augmentation for rotor opening, soft landing and/or increased maneuvering range.

In this system, the rotor blades, 100-ft. long and hinged at the booster interstage section, are folded down the sides of the booster during powered flight. Shortly after booster burnout, the tip rockets are fired and the rotor blades are pushed up and open by centrifugal force. Variation of rotor drag force, says Lysdale, may allow a controlled deceleration program during re-entry. After re-entry deceleration, the booster will descend at equilibrium with a sink rate of approximately 55 fps. at sea level.

During descent, the booster, equipped with remotely operated cyclic rotor controls, can be maneuvered within a 20-mi. radius to a designated landing site. Then, increasing the collective pitch of the rotor blades enough to convert approximately 15% of the blades' rotational energy to lift will enable the booster to land with zero impact velocity.

The fourth recovery concept discussed by Lysdale combined dive brakes with air-breathing engines which would burn residual rocket fuel. The engines would support the booster and permit limited maneuvering for landing control. Analysis of this combined dive brake-engine recovery system showed, however, that it would weigh 111,500 lb. (25% of the total booster burnout weight, 7.3% of the booster payload) and would entail a velocity penalty of 480 fps.

These factors combined with the impractical 5-10 mi. maneuvering range and an estimated development cost of $150 million, Lysdale explained, eliminated this system from further consideration.

By comparison, the weight of the dive brake-parachute-retrorocket recovery system, as calculated by Aerojet engineers, is 44,000 lb. This would amount to 10% of the booster burnout weight or 2.9% of the booster payload and would reduce booster burnout velocity by 190 fps. These same figures also apply for the controlled rotary wing recovery system. The dive brake-parachute-balloon recovery system devised for the Cosmos would weigh 59,000 lb., which would be 13% of burnout weight or 3.9% of booster payload. The velocity penalty for this system is 250 fps.

Comparison of the technical feasibility of these three systems, says Lysdale, indicates that the retrorocket and balloon systems are entirely feasible within the limits of current technology. On the other hand, he adds, many aspects of the controlled rotary wing concept are currently unproven such as the ability to autorotate at supersonic sink rates. But Aerojet engineers assume that the research and development on rotary wing recovery systems will prove successful, though costly, and consequently consider this as a competitive booster recovery concept.

It is in the economic comparison of the three recovery systems that the dive brake-parachute-balloon concept comes to the fore. This economic evaluation, says Lysdale, includes all pertinent development, hardware and operational costs for the expendable booster program and for the booster recovery operations. This includes recovery system design, development and hardware costs, recovery operation costs, booster and recovery system rejuvenation costs, and the cost of reduced booster payload. Total program costs are based on an estimated average of six flights per recoverable booster. Rejuvenation costs are calculated at approximately 40% for water impact recovery and 14% for balloon recovery.

Cost calculations, says Lysdale, indicate that the dive brake-parachute-retrorocket system and the dive brake-parachute-balloon system will break even on the third Cosmos flight, while the rotary wing system will not show a savings before the tenth flight. By the tenth flight, the balloon system will show a savings of $57 million and the retrorocket system a savings of $37 million. After 50 flights, the balloon recovery system will have saved $349 million or 38% of the total booster program cost; the retrorocket, $226 million or approximately 24% of total booster program cost; and the rotary wing, $153 million about 17%. Evaluation of winged recoverable booster systems, Lysdale says, indicates they are not competitive for programs of 50 flights or less, due to high development and hardware costs.

Hypersonic Vehicle Cooling

Lithium hydride and absorbent materials capable of holding large amounts of water show promise as heat sinks for cooling hypersonic vehicles, it was reported to the IAS meeting by three NASA scientists.

Boiling lithium looks even more promising, Robert O. Hickel, the author who delivered the report, told Aviation Week. But because boiling lithium appeared "too hairy to handle," it was not investigated in the recently completed NASA study, which started shortly after the Dyna-Soar concept was first proposed.

Cosmos Plug-Nozzle Booster

Cosmos, Aerojet-General's 6-million-lb.-thrust liquid propellant rocket booster, has been incorporated in a new and more inclusive large booster program now under way at the company's liquid-propellant rocket plant.

In its current design configuration, the plug-nozzle Cosmos booster has a maximum diameter of 57.2 ft. and is 149.5-ft. long. Inert weight of the vehicle is 350,000 lb. The vehicle uses a pressurized liquid oxygen-liquid hydrogen feed system with ablative chamber cooling and produces 6 million lb. of thrust. Heavy pressurized propellant tankage makes the booster relatively rugged and adaptable to recovery.

Design of the vehicle and associated recovery systems was carried out by Aerojet's Spacecraft Division at Azusa as part of a company-sponsored program to develop a "low-cost, ultra-large vehicle that could be built with existing technology." Of the several different concepts studied, the particular one represented by Cosmos looked most economical and generally attractive. The plug nozzle feature, says one Aerojet engineer, not only offered a significant size reduction but also looked as though it would easily lend itself to thrust vector control. The ability to test individual combustion chamber segments without having to fire the complete engine until actual launch was expected to cut development costs.

The 6-million-lb.-thrust figure was arbitrarily selected as a working number for a vehicle that would be big enough to have most of the problems anticipated for very large boosters. Detailed studies of this particular concept reportedly were carried out over a thrust range from 1.5 million lb. to 30 million lb.

Cosmos has been the subject of several unsolicited proposals made by Aerojet engineers who foresee a definite need for liquid boosters of this size materializing shortly. Many features of the vehicle such as the plug nozzle and LO_2-LH_2 propellant system are believed to have formed the basis for Aerojet's bid for the Saturn upper stage engine (AW Feb. 1, p. 16). To date the company has not been able to sell the concept.

All data collected by the Spacecraft Division on the Cosmos program has now been turned over to the company's Liquid Propellant Rocket plant in Sacramento, where the program will be continued and expanded. In general, it is expected that each facet of the concept will be further evaluated in significantly more detail. Among other things, Aerojet engineers will investigate economics of plug nozzle-segmented engine approach to a 6-million-lb.-thrust engine as opposed to the economics of clustering four 1.5-million-lb.-thrust engines as suggested in the Nova concept.

Nuclear Power Proposed for Space Gains

New York—Development of nuclear propulsion systems and secondary power sources appears essential to the success of the more ambitious U. S. space missions planned for the next decade.

It is no longer a question of the advantages and disadvantages of nuclear energy versus those of chemical or solar energy. In some cases, nuclear-powered systems (see p. 71, 87) provide the only means of accomplishing mission objectives. For those missions where there is a choice, nuclear energy often offers significant advantages such as expanding permissible launching times from days to weeks.

This evaluation of nuclear electric power for space missions was presented here last week at the annual meeting of the Institute of Aerospace Sciences by two Jet Propulsion Laboratory scientists, Terry W. Koerner and John J. Paulson, who reported some results of research carried out by JPL for the National Aeronautics and Space Administration.

As secondary power sources, Koerner and Paulson said, radioisotope thermoelectric generators significantly outperform conventional batteries. At a 15-watt level, for example, a curium fueled RTG will supply 3,600 watt hr./lb. versus 80 for a battery. Radioisotope theremoelectric generator devices are best suited for applications requiring small amounts of power for extended periods, particularly if solar energy is not adequately available such as on Jupiter or in landing missions involving operation during night portion of the cycle. On the other hand, radioisotope thermoelectric generators do not appear suited to large power requirements due to their high specific weight.

On the basis of specific weight, reactor power sources become competitive with solar photovoltaic panels at a power level of 0.7-3 kw. This corresponds to weights in the 400-600 lb. range and is based on missions in the Mars and Venus class. For longer missions, reactors become the choice at lower power levels.

The solar panel array tentatively selected for Mariner B Mars mission weighs approximately 200 lb., Koerner and Paulson pointed out. Even including the batteries and converters, the Mariner B solar power system is expected to weigh less than the 350 lb. figured for Snap 10 reactor source (without shielding), which has roughly the same power capability. At this time, according to Koerner and Paulson, a solar thermionic system, offering a specific weight two-thirds lower than that of the solar panels, looks like a promising alternative for Mariner B but still needs considerable work.

Saturn Development

The earliest time at which nuclear secondary power devices will prove advantageous hinges on the development of a Saturn-boosted vehicle capable of placing spacecraft carrying 500 lb. or more power system weight on trajectories to the moon, Mars and Venus. But even the most advanced, chemically fueled Saturn configuration now planned, Koerner and Paulson state, doesn't appear capable of delivering a payload to Jupiter large enough to include a secondary power reactor. It appears that a more exotic propulsion system such as a reactor-powered ion engine will be required, they add, in order to deliver a vehicle with enough secondary power capability to provide adequate communication bandwidths.

In their evaluation of nuclear electric propulsion for spacecraft, Koerner and Paulson considered four missions: (from earth orbit) Mars satellite, solar probe, Jupiter probe, and an out-of-the-ecliptic probe. Their investigation showed that the electric propulsion systems offered advantages for all but the solar probe. The principal advantages of the electrical propulsion over the chemical were the reduced time required to spiral into planetary orbit and the power available after arrival for scientific instruments and communications.

Further comparison of chemical and electric propulsion systems indicated

Power and Weight Estimates for Space Missions

Date	System	Vehicle	Mission	Raw Power	Power System Weight
1961	Ranger 1 and 2	Atlas-Agena	Lunar	160	256
1962	Ranger 3, 4, and 5	Atlas-Agena	Lunar	160	144
1962	Mariner A	Atlas-Centaur	Venus	300	210
1963-64	Mariner B	Atlas-Centaur	Mars	350	300
1963-65	Surveyor	Atlas-Centaur	Lunar	....	....
1965-70	Voyager	Saturn	Mars, Venus, Mercury, Jupiter	2500	500-1000
1966-71	Prospector	Saturn	Lunar	....	....

CHART prepared by Jet Propulsion Laboratory scientists compares different power sources with regard to system weight and power level.

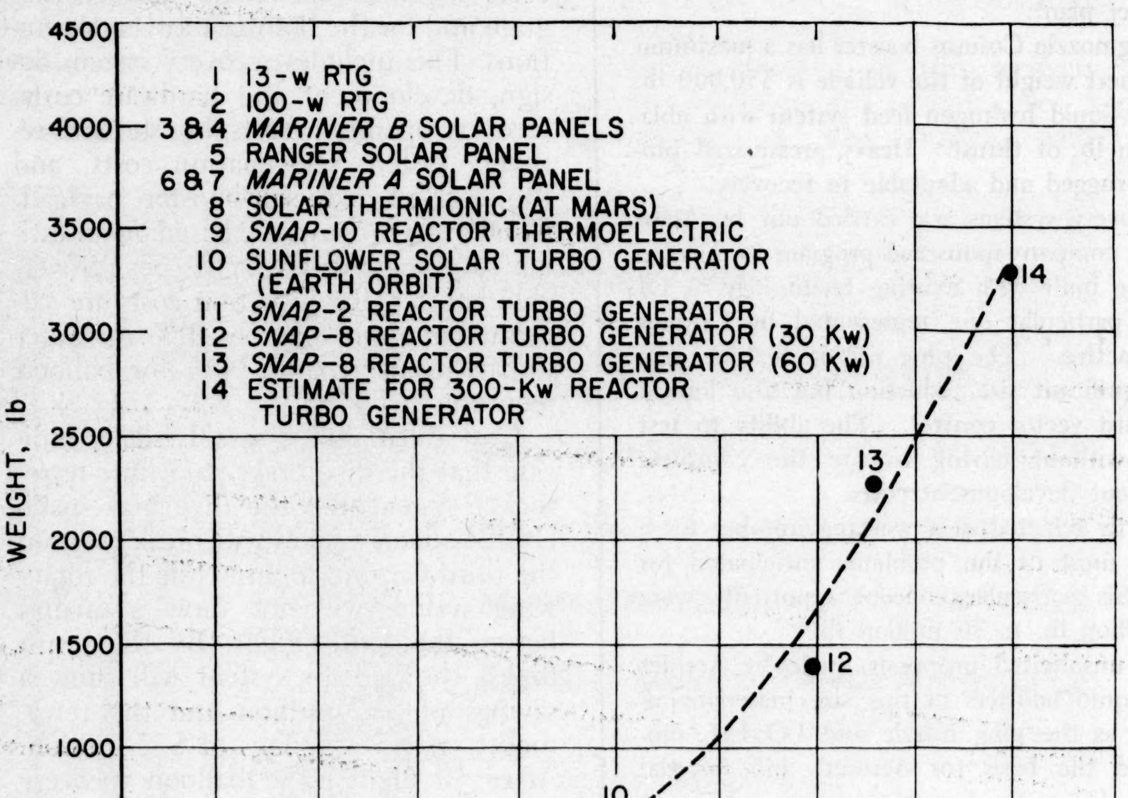
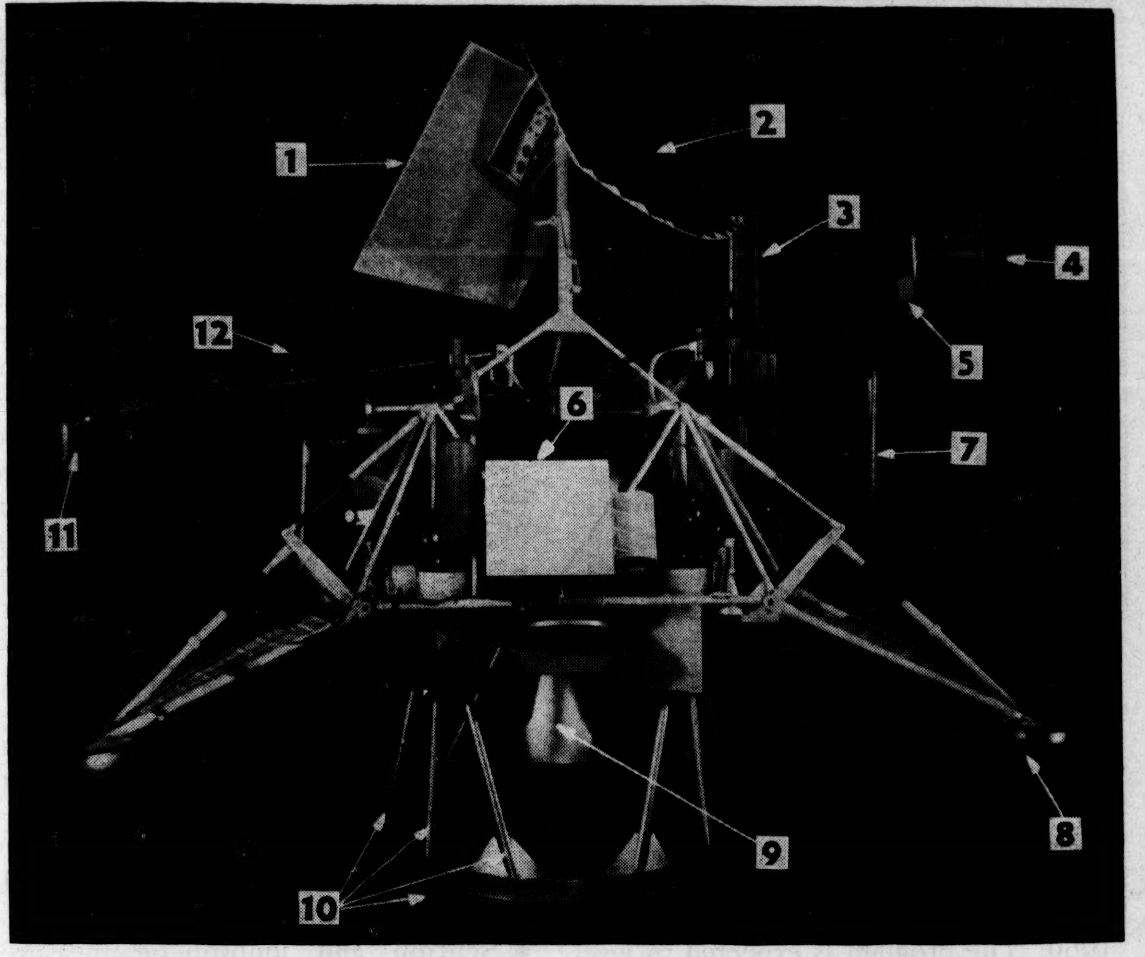


TABLE shows power requirements (in watts) and weights (in pounds) of secondary power systems on U. S. spacecraft scheduled for launch in the next decade. Values for the secondary power systems on Surveyor and Prospector will be left up to the contractors.

that for some missions the electric system was unique. Among the unique missions listed by Koerner and Paulson were the following: Mars capture with a 12,000 lb. payload; Mars orbit with an 11,500-lb. payload; 600-day Jupiter probe with a 10,500-lb. payload; and Mercury capture with a 5,000-lb. payload.

Koerner and Paulson pointed out that the nuclear power devices still require a great deal of major engineering work.

Also, some important factors such as cost were not considered in their investigation. But when power requirements reach a level of 50 lb./kw. or less, the JPL men concluded, the nuclear source appears to be the only one available with the required lifetime expectation.



Hughes Displays Project Surveyor Model

Model of Surveyor soft-landing lunar spacecraft shows 11-ft.-high tripod configuration resting on circular truss frame (see story p. 50). Note antenna (1), solar panel (2), drill support (3), plasma probe (4), magnetometer (5), spherical solid propellant main propulsion unit (6), neutron activator tube (7), tripod footprint (8), propulsion nozzle (9), truss support for model (10), lunar surface geophysical experiments (11), and ionization gage (12).

Republic Develops Sub Control Stick

New York—Republic Aviation Corp. engineers have developed and tested a fighter-type control stick system for high-speed submarines.

The new system, which applies aircraft techniques and draws directly on the company's experience with highspeed control systems, was tested on the USS Albacore, the Navy's experimental submarine used for technical development of undersea boats. In the Albacore tests, one man could control changes in depth and course, a procedure which usually requires two men and sometimes three men.

Republic's studies of the submarine control system were initiated by knowledge that the Navy's next generation of submarines will have to operate deeper and faster with higher maneuverability. These requirements will impose limitations of size and weight on the submarine and in turn will force improvements in hydrodynamics, propulsion, structures and systems.

The Republic control system is basically a cable type, traditional in aircraft design. There is direct mechanical linkage between the gimbal-mounted stick and the hydraulic servo slide valves mounted adjacent to the submarine's rudder and stern plane. All driving mechanisms, gimbal pivots and synchro resolvers are boxed at the base of the stick.

Trimmable feel capsules provide artificial feel at the stick and magnetic dampers give dynamic stick forces. By using a standard thumb control button at the top of the stick, the submariner can change the neutral point of the stick feel force. This means that he can trim to hold a desired rudder or stern plane angle with no stick force.

Other switches on the stock grip can be used to control intercommunications or to shift ballast for trim of the boat.

Republic engineer Joseph D. Malloy said the next step is to reduce the control system further by making it a miniaturized electrical system which would be built to establish feasibility.

Republic's submarine control trainer was developed under contract with the U. S. Naval Training Device Center to teach helmsmen, planesmen and diving officers of Skipjack and Thresher class submarines how to control these boats at high speed while submerged. The trainer is a simulated control station, an analog computer to produce submarine response to the control deflections, and an electro-hydraulic servo system to pitch and roll the entire, gimbal-mounted control station.

The trainer seats two men side by side, with the instructor at a desk behind the port operator. As in most synthetic training devices, he can set up initial conditions for problems, create instrument or steering control failures, and monitor and score the students.

Computer design aim was to provide a unit with as few components as possible, and which would be reliable and simple to maintain. It was also planned to use as many available components without modification as were available at the time of the design.

Republic designers, working under Malloy as project engineer, developed a small computer using 23 operation amplifiers, and four electro-mechanical servo-multipliers.

Instrument display required eleven voltmeters, two operational amplifiers and six electro-mechanical servos. Malloy reported the computer design met the requirements.

IAS 'Audit'

New York—"Personality audit" of the Institute of the Aerospace Sciences has been submitted to IAS staff and officers by Herbert Harris, public affairs consultant, at the request of the Institute. Purpose was to find what Harris termed the "psychological silhouette" of the IAS as seen by a representative cross-section of its membership.

Titan II for Dyna-Soar

Washington—Air Force will use Titan II to boost the Dyna-Soar vehicle in its initial flight tests, eliminating the Titan I booster from the program. Use of Titan II will permit a higher Dyna-Soar payload on these first ballistic flights. The booster will be a storeable-fuel Titan II built at Martin Co.'s Denver Division and adapted by company's Baltimore Division.

Rockets to Test Spacecraft Instruments

Washington—Flight tests of satellite and probe instruments and inexpensive space environment studies will be continued in a National Aeronautics and Space Administration program of ballistic rocket flights which will reach a peak of 160 launches this year.

NASA's rocket program is separated into these major operational categories:

- **Scientific sounding rockets:** a minimum of 80 and maximum of 100 will be fired in 1961 to altitudes up to 1,300 mi. with payloads weighing 50-150 lb. Broad objectives are to sample the environment and measure particles.
- **Space mechanics experiments:** preliminary schedule is 63 launchings to study the effects of space on satellite and probe payload components.

The diverse sounding rocket program began in 1959 with about 20 shots and rose to about 60 last year. There also were 63 space mechanics missions in 1960. The program is expected to level off at the 1961 pace of 160 shots. NASA had launched about 3,000 rockets for aerodynamics studies prior to 1959.

About 75% of the scientific payloads this year will be launched by Nike-Cajun, Aerobee 150 and Javelin (Argo D-4) rockets. Current plan is fire 40 Nike-Cajuns, 20 Aerobee 150s, and 12 Javelins. Remainder of the launchings will be made by Journeyman (Argo D-8), Aerobee 100 Junior and Aerobee 300 Sparrowbee rockets.

NASA plans to fire most experiments from Wallops Station. Approximately 25 will be launched from Ft. Churchill, Canada, and one or two from Pacific Missile Range.

Asp Problems

The agency hopes an engineering evaluation now being conducted will correct a series of malfunctions in the Nike-Asp. The Asp has a higher performance capability than Cajun, but several failures last summer resulted in suspension of the use of the Asp second-stage motor. The Nike-Asp combination had a 90% reliability record until the series of successive failures.

The Nike-Asp can carry 50 lb. to 150 mi., while the Nike-Cajun can lift the same weight only to 100 mi.

Cajun was substituted for the Asp in the Italian sodium flare launches, which were delayed until mid-January from last September (AW Oct. 17, p. 23). Engineering studies to fix the Asp malfunction have included instrumented firings to analyze stability, structure, heating, vibration and propellant grain.

NASA will use sounding rockets to loft preliminary versions of satellite and probe instruments to determine whether these instruments will work and to calibrate them for accuracy. Sounding rocket payloads this year will carry astronomical observatory (OAO) experiments in flight tests.

Sounding Rockets Used

In addition to flight testing instruments, sounding rockets are being used in these programs:

- **Astronomy,** using Aerobee 150 rockets to carry ultra-violet spectrographs which determine the spectra of stars.
- **Neutron and ionospheric** measurements in the upper atmosphere, also with Aerobee payloads.
- **Proton beam measurements** with recoverable emulsion stacks in solar beam and nuclear emulsion packages. Aerobee is used to launch solar beam experiments during periods of high solar activity, and Argo D-8 was used to launch the nuclear emulsion recovery vehicle (Nerv).
- **Cloud cover photography,** using Aerobee 100 rockets to carry recoverable camera packs.
- **Atmospheric temperature** variations measurements, made with Nike-Cajun grenade payloads. Emphasis is on temperatures between 25 and 75 mi., and measurements are made by photographing a grenade flash and comparing flash time with the time the sound of the explosion reaches the ground.

Characteristics of the workhorse sounding rockets:

- **Nike-Cajun** is a two-stage all-solid rocket costing about $10,000 without payload. It can carry 50 lb. to a 90-mi. altitude.
- **Aerobee 150** is a single-stage liquid rocket costing $30,000, and able to carry 150 lb. to 150 mi.
- **Javelin** is a four-stage all-solid vehicle costing $50,000 and capable of boosting 50 lb. to 800 mi.

The Argo D-8 Journeyman, which carried the Nerv experiment, can take 130 lb. to 1,300 mi. It costs about $100,000.

NASA feels the existing workhorse sounding rockets have satisfactory reliability, but there is a gap in performance capability creating a future requirement for an inexpensive rocket able to carry 100-500 lb. up to 1,000 mi.

The agency is using a wide variety of rockets at Wallops Station to continue its 15-year-old research program in which rockets extend the Mach and Reynolds numbers of wind tunnels.

Most of the rocket-boosted research through 1958 at Wallops was in aerodynamics, but this field has dwindled to 15-20% of the current Wallops effort to make way for a number of space-oriented programs. Development flights are being made for specific re-entry configurations for the Defense Department, and basic research is under way in re-entry physics, re-entry aerodynamics using plunging trajectories and stability of re-entry bodies.

Among applications flights planned this year are:

- **Solar collector opening** characteristics in a zero-g environment, as payload of an Argo D-4.
- **Wind shear study** of chemicals which are visible in the daytime. Current studies of high altitude wind activity can be made only at dawn or dusk with sodium flares. Langley Research Center plans to use Nike-Cajuns for these tests.
- **Horizon sensor** development for spacecraft stability.

Re-Entry Physics

Re-entry physics will be studied with Trailblazer I and II (AW Jan. 16, p. 102) and a four-stage vehicle made of Honest John, two Nike boosters and a Recruit will be used to study dynamics over the Mach range of 0.5-10. Four and five-stage rockets based on the Castor booster are planned for heat transfer studies at velocities up to Mach 20.

Heat transfer and structural materials tests are planned for Scout payloads, which can reach velocities of 20,000-30,000 fps.

Typhon Bidders

Washington—Competition for development of Navy's Typhon fleet air defense missile system has been narrowed to Boeing, Bendix and North American Aviation, but no final decision is expected before July.

Ion Engine Use Study Won by United Aircraft

Washington—Ion rocket engine uses will be studied by United Aircraft Corp. Research Laboratories under a 12-month, $100,000 contract being negotiated with the National Aeronautics and Space Administration.

Study involves payloads, trajectories, engine operating times, schedules, and combination ion-chemical engines. Thrust ranges will be 0.1 lb. to 1 mw (AW Oct. 31, p. 28). First operational ion engines will be powered by the 30-kw. Snap 8 and will be launched by either Centaur or Saturn boosters.

United Aircraft will study use of ion engines for Mars, Venus and Jupiter orbital missions and for a flight past Mercury.

House Republicans Plan to Fight Changing of Defense Programs

By Katherine Johnsen

Washington—House Republicans formally proclaimed a "line of battle" last week against any significant changes in the level, long-haul, $40 billion-a-year Eisenhower defense program in a series of speeches sponsored by the Republican Policy Committee.

The Republican spokesmen declared themselves against any substantial decrease in the program, as well as any substantial increase.

During the election campaign, President Kennedy called for prompt action "to give us a nuclear retaliatory power second to none" and estimated the additional cost at $2 to $3 billion.

Welfare Cost

The Republicans argued that the cost of implementing social welfare programs promised in the Democratic campaign platform will not only preclude the Kennedy Administration from sustaining an increased defense program, but that before long, as the public clamor for these liberal programs mounts, it will be forced to cut deeply into military spending to finance them. They recalled "the Louis Johnson era" immediately before the Korean War when the Truman Administration reduced defense to an $11 billion-a-year level in favor of popular social welfare measures.

In addition to warning against a military strength that "ebbs and flows as the Kremlin smiles or frowns," the objective of the Republicans was to place on the record, in detail, the accomplishments of the Eisenhower Administrations "for future reference"—probably during political campaigns.

Republican Spokesmen

Republican spokesmen were Rep. Leslie Arends (Ill.), Rep. William Bray (Ind.), and Rep. Bob Wilson (Calif.) of the Armed Services Committee; Rep. Gerald Ford (Mich.), Rep. Melvin Laird (Wis.), and Rep. John Rhodes (Ariz.) of the Appropriations Committee; Rep. Perkins Bass (N. H.) of the Space Committee; and Rep. William Widnall (N. J.) of the Joint Congressional Economic Committee.

Rep. Laird said that Democratic-controlled Congresses consistently reduced Eisenhower's defense requests in non-election years and consistently increased them in election years. He noted that Congress cut the President's budgets for fiscal years 1956, 1958, and 1960 by a total $3.4 billion. The increases made by Congress for the fiscal years 1957, 1959 and 1961 totaled $1.8 billion. The result was a net reduction of $1.6 billion in the total asked by Eisenhower for the six years.

The Eisenhower Administration impounded $220 million of the total $1.8 billion Congress added to the defense budget for Fiscal 1961. The impounded funds, which may be released by the Kennedy Administration, were: Army modernization, $45 million; fleet ballistic missile program, $17.5 million; airlift modernization, $22.4 million; air defense fighters, $97 million; North American B-70 bomber, $29.3 million, and $9.2 million for Reserve and Guard construction. Congress cut Eisenhower requests $1.1 billion. This left a net increase by Congress for Fiscal 1961 of approximately $700 million.

Rep. Bass pointed out that the Democratic-controlled Congress cut the budget for National Aeronautics and Space Administration $45 million for Fiscal 1958, $6.7 million for Fiscal 1959, and $23.2 million for Fiscal 1960—a total of $74.9 million.

Kennedy Budget Policy

Washington—David E. Bell, director of the Bureau of the Budget, last week ordered new Kennedy Administration agency and department heads to keep changes in their budgets for Fiscal 1961 and 1962 to a minimum.

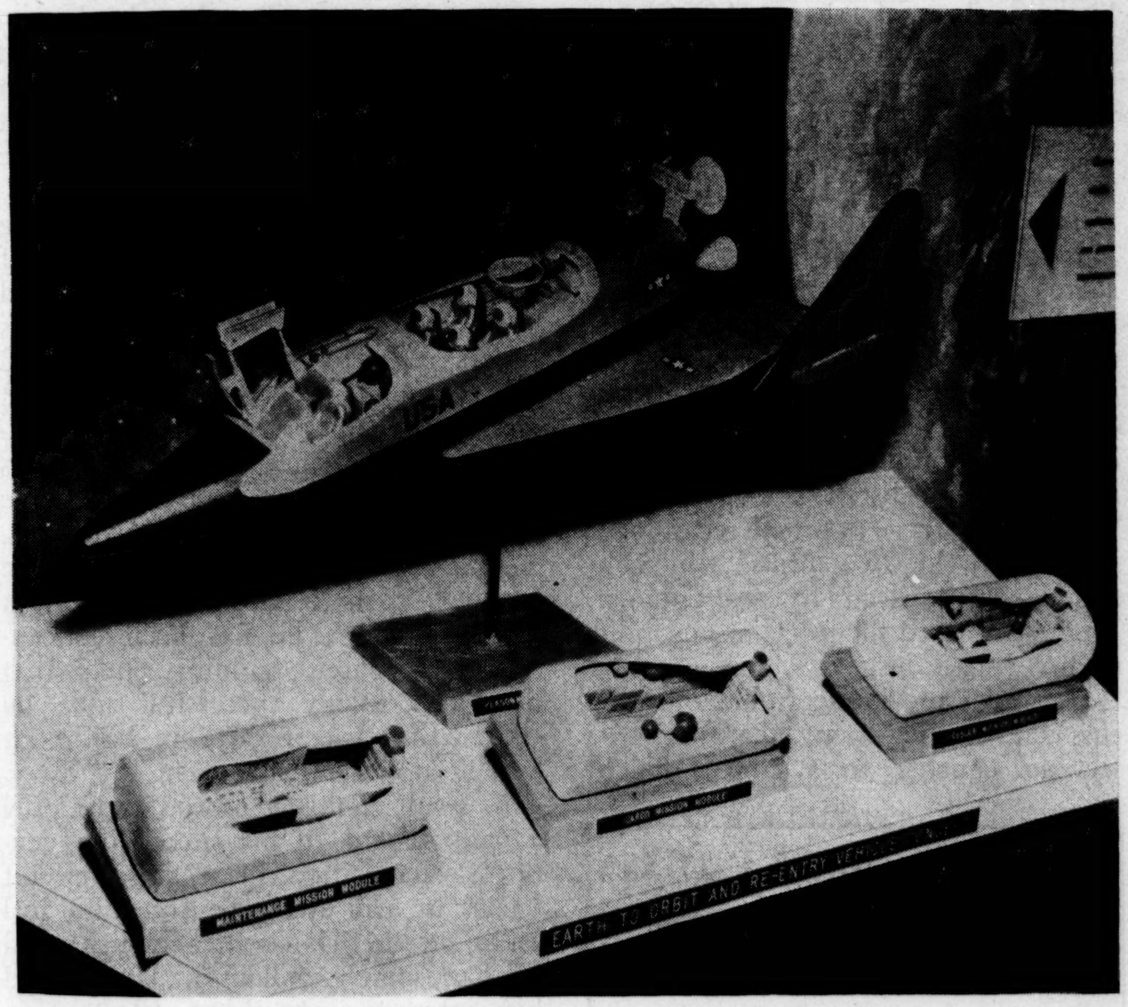
He said Budget Bureau will not consider changes "unless the agency head feels very strongly that some modification is unavoidable," and he set Feb. 20 for the submission of proposals.

Bell also announced that all changes in the Eisenhower budgets must be cleared by the Budget Bureau before being presented to Congress.

Despite the congressional cuts, Rhodes declared, the Eisenhower defense policies "have brought this nation to a pinnacle of might never before attained by any other state in the history of mankind."

Strike Forces Compared

As the Kennedy Administration assumed office, Laird declared, Russia's nuclear strike force of 235 missiles and bombers capable of hitting U. S. targets


USA
MAINTENANCE MISSION MODULE
EARTH TO ORBIT AND RE-ENTRY VEHICLE

First Photos of Norair SLOMAR Concept

Northrop Corp.'s Norair Division's entry in USAF's request for studies from four companies for a manned space, logistics supply, maintenance and rescue (SLOMAR) vehicle is shown in model form. Other companies studying project are Martin (AW Jan. 2, p. 43), Convair and Douglas. Northrop proposal is believed to be only one featuring interchangeable modules tailored to each particular mission. Vehicle has its own search and lock-on radar system. Device shown extended above cockpit is grappling and hook-on equipment for engaging orbiting spacecraft with which SLOMAR is designed to rendezvous. Indications are that takeoff booster would probably be on the order of a Saturn type.

compared with "well over 2,000" U.S. nuclear-carrying vehicles capable of reaching Russia.

He said Russia has approximately 35 operational intercontinental ballistic missiles and about 200 long-range bombers.

"Her fleet of medium-range bombers have a questionable capacity for hitting U.S. targets," the Republican Congressman commented.

Laird gave this breakdown of the U.S. capability: two submarines with a combined total of 32 Polaris missiles; "about 16 intercontinental Atlas missiles, a number in firing position"; over 600 long-range B-52 bombers; "nearly 1,400" B-47 medium-range bombers capable of being refueled; medium-range B-58 Hustlers "only recently placed in operation" by Strategic Air Command; over 200 carrier-based aircraft; 18 wings of tactical aircraft globally deployed; 60 Thor intermediate range ballistic missiles deployed in England, and 30 Jupiter IRBMs being installed in Italy.

Rep. Windall cautioned against increases in the defense budget "lest they lead to shifts away from private consumption, private investment, nondefense public spending and low priority defense items themselves."

Rep. Rhodes warned against shifting funds from defense to other programs: "We cannot permit any forays by those interested in draining our economy for the purpose of engaging in the implementation of the fuzzy tenets of liberal social engineering."

Ling Strives for Vought Control

Dallas, Tex.—James J. Ling's determination to gain control of Chance Vought Corp. continued to be evident last week, although the Dallas aerospace company was more voluble in contrast to Ling's continued silence on future plans.

Indications are that Ling will step up his attempts to purchase a controlling number of shares in Chance Vought—Ling-Temco advertised nationally last week that it will buy some 150,000 shares of the company at $43.50 per share—and a source close to one of the firms hinted that Ling would invite a further tender soon.

Ling apparently has at least 150,000 shares of the company now, which would place his holdings between 10 and 15% of Chance Vought's total outstanding stock. And, last week, Chance Vought President Fred O. Detweiler indicated that Vought management would listen to a Ling-Temco Electronics, Inc., proposal regarding a merger of the two firms, which he added, "could lead to negotiations." Ling maintained silence as to possibility of any discussions.

Detweiler previously would only discuss the matter to say that he could see no benefits to Chance Vought stockholder through a combination of the companies, pointing out that Ling-Temco has stated a policy of plowing profits back into its business and relinquishing dividends for the time being, while Chance Vought is currently paying dividends.

While Chance Vought management has concentrated on wooing its stockholders, Ling is still working hardest on garnering the company's shares—as of last week there was no evidence that he had yet started to solicit Vought stockholder support. Indications are also that he would not make his intentions clear, as to whether he is seeking control of an outright acquisition of Chance Vought, until he clearly held a commanding stock position. If his initial offer for tenders for 150,000 shares would be successful, it would clearly put Ling in a commanding position, which Chance Vought might attempt to counter by releasing a large block of as yet unissued stock.

Ling's primary interest in Chance Vought is its electronics business, a facet on which he has been concentrating an empire-building career that has been highly successful since he started Ling Electric Co., in 1947 with $3,000 after discharge from the Navy. This small company proved to be only a spring-board to his succeeding ventures. Acquisition of a closed-circuit television firm and a venture into real estate in the Dallas area, which paid off handsomely, followed. He merged his interests into Ling Electronics, Inc., in 1959 and then began a rapid expansion program in the electronics field, picking up United Electronics Co. Newark, N. J., and Calidyne Co., Winchester, Mass., in 1958 in combination cash-stock transfer deals. In 1959 Ling acquired three more companies—Altec, Anaheim, Calif., on a share-for-share basis trade, University Loudspeakers, Inc., White Plains, N.Y., and Continental Electronics Manufacturing Co., Inc., Dallas, both for cash. Only a few thousand dollars were involved in his first acquisition, on one of his mergers in 1959 he paid $3.6 million. Then last year, Ling merged Temco on a stock exchange basis and recently paid $3.5 million to buy Ed Friedrich, Inc., San Antonio, an air conditioning manufacturer.

On the side, he has privately invested some $2.5 million and became a major shareholder in Electro Sciences, Inc., Dallas.

Cracks Ground 5 F-105s

New York—Air Force has grounded five Republic F-105 fighter-bombers because evidence of stress corrosion causing cracks in the stabilator forging on these aircraft was discovered during routine inspections.

All F-105s are being checked in the field for similar cracks. Those F-105s without cracks are being returned to flight status. Republic and Air Force are working out a modification for the grounded aircraft.

Norstad Plans Jutland Peninsula Command

Paris—Danish and West German governments are considering a proposal by Gen. Lauris Norstad for establishment of semi-autonomous air and ground commands within the North Atlantic Treaty Organization for the defense of the vulnerable Jutland peninsula.

Encompassing the Danish mainland and the German province of Schleswig-Holstein, the peninsula extends from the North European coastline and could be cut off from present NATO command structures by any determined thrust from East Germany.

For this reason, Gen. Norstad, supreme allied commander in Europe, has proposed that the Danish and German air units in the area be welded into a single NATO command that would give them freedom of movement if and when the peninsula became severed from the normal command structures in southern Germany and Norway.

Similarly, most of the present "Land Denmark" command would be combined with NATO's northern army group in Schleswig-Holstein as a separate entity. Eastern Danish islands that are not directly connected to the peninsula would be formed into a separate unit. Both the Jutland and the Danish Isle commands would remain under the organizational responsibility of Allied Forces, Northern Europe, headquartered in Oslo.

Air units concerned would be the eight combat squadrons of the Royal Danish air force with F-84G and RF-84Fs, F-86D and F-100s, Gloster Meteors and Hawker Hunters.

West German air force currently has one wing of F-84F fighter bombers and a reconnaissance wing of RF-84Fs in Schleswig-Holstein. However, neither has yet been assigned to NATO and may not be before next year.

Under the Norstad plan, which must be ratified by the two governments involved before becoming effective, the air units would remain under the operational control of Allied Air Forces, Northern Europe, in Oslo.

Congress Prepares for Kennedy Changes

By Ford Eastman

Washington—President Kennedy's State of the Union Message will set the stage this week for the coming legislative year as Congress organizes itself and prepares to handle the new Administration's proposals for strengthening defense, space and other national programs.

Although specific recommendations will be submitted later, congressional leaders and investigating committees are already laying the groundwork for action in anticipation of Administration requests.

A major portion of congressional activity this session will center around reviews of Fiscal 1962 budget requests submitted by the Eisenhower Administration for defense, space and civil aviation and around additional requests President Kennedy is expected to make in areas he considers essential (see p. 27).

Possible areas of inquiry include:

- **Missile program**—Determination of the number and types needed to provide an adequate deterrent to aggression.
- **Airborne alert program**—Determination of whether sufficient funds have been requested to provide a continuous airborne alert of the magnitude necessary to discourage a nuclear attack on the U. S. until the missile lag is eliminated.
- **North American B-70**—Development, to see if it is sufficiently funded.

Congress also may seek to determine whether there is a requirement for further development of supersonic long-range interceptor aircraft such as the North American F-108, which was canceled by the last administration, or whether missiles will replace the manned aircraft.

- **Airlift capabilities** and what additional effort is needed in Army modernization and ship construction programs to provide a strong limited war capability as urged by President Kennedy during his campaign.
- **Aircraft Nuclear Propulsion** program, to determine if it should be continued "on one technical approach" as suggested by the Eisenhower Administration (AW Jan. 23, p. 28) or proceed with development of both direct and indirect cycle engines, and whether proposals for early flight should be reconsidered. Progress being made in development of nuclear power for rockets and space vehicles is also expected to be reviewed.
- **Report of a special task force** on space headed by Dr. Jerome B. Wiesner, White House science adviser, which recommends a single military space program, re-evaluation of the civilian space effort and acceleration of ballistic missile programs (AW Jan. 23, p. 79).
- **Need for proposals** to increase the federal aid to airports program from $63 million annually to $100 million annually and for legislation authorizing government-guaranteed loans to airline operators for the purchase of all-cargo aircraft.
- **Progress of the national program** to develop a supersonic transport. Fiscal 1961 funds amounting to $5 million were earmarked for design studies of a Mach 3 commercial transport (AW Jan. 16, p. 43).
- **Open hearings on proposals** to establish a Department of Transportation at the Cabinet level and on other proposals for a less drastic revision of the transportation picture.
- **Air safety problems.** A review already is scheduled for early next month by the Senate Interstate and Foreign Commerce Transportation Subcommittee, headed by Sen. Mike Monroney (D.-Okla.).

Congress is also expected to probe Defense Department reorganization plans. Although the President has not endorsed a plan prepared by a group headed by Sen. Stuart Symington (D.-Mo.), which recommends drastic revisions (AW Dec. 12, p. 34), there are indications that at least some of the less controversial recommendations may be implemented this year.

Funding of additional programs, especially in the civil aviation field, could lead to extension of corporate and excise tax rates now scheduled for reduction or termination July 1, raising of the tax on aviation fuels to about four cents or more a gallon, or the assessment of other charges against commercial airline operators.

Legislation already has been introduced and referred to committees which would:

- **Amend the National Space Act** to permit waiving of government claims to patent rights resulting from government-financed research and development.
- **Amend the same act** to give the President authority to designate the Vice President as chairman of the Space Council.
- **Require that at least 50%** of the government's passenger and cargo air transportation needs be filled by U. S. operators of civil aircraft.
- **Amend the Civil Aeronautics Act** to provide for the claiming of damages by persons who have been "overbooked" by airlines in confirming space reservations.
- **Amend the Federal Aviation Act** to establish a committee under the Civil Aeronautics Board to review FAA saftey regulations.
- **Amend the same act** to give CAB certain review authority over the FAA administrator and to limit his authority over airmen's certificates.

In the last session, committees of the Democratic Congress took a critical look at Republican programs and actions with a view to creating campaign issues. This session, committees will explore problem areas in the various establishments and consider programs and revisions with a view to helping the Administration establish a record to stand on during the next election.

Senate committees have been organized but a controversy over proposed changes on the House Rules Committee has delayed committee organization there.

The first hearing scheduled was by the House Committee on Science and Astronautics, headed by Rep. Overton Brooks (D.-La.), to review Defense research and development programs. This probably will be held next week.

Other matters which this Committee may explore include the national booster program, duplication in the life sciences, communication satellite development and other space programs. Project Rover and other nuclear propulsion programs, the controversy over whether the military or civilian agency should play a dominate role in space exploration, and whether Project Mercury has been slipping and whether or not it should, continue to receive top priority.

The Senate Committee on Aeronautical and Space Science, headed by Sen. Robert S. Kerr (D.-Okla.), has asked for $135,000 in funds for investigations and study. As a result, it probably will be more active than in the past. No program is expected to be announced until Kerr has studied a staff report and singled out areas that need immediate attention. First action will be confirmation hearings on appointments to the National Aeronautics and Space Administration and National Space Council.

Other committees and actions they may undertake include:

- **House Armed Services** Investigating Subcommittee—Investigation of contract costs, which account for about 95% of the total contract price, and any known over-pricing. This subcommittee works closely with the General Accounting Office, which has several investigations of missile management under way.

- **Senate Armed Services** Committee will hold prior authorization hearings on procurement of aircraft, missiles and ships, as will House Armed Services Committee. This is the first time authorization has been required before appropriation in this field.

The Senate group also will issue a report regarding updating of the conflict of interest law.

- **House Government Operations** Subcommittee on Military Operations will issue reports on status of Military Air Transport Service aircraft modernization and the organization of Aerospace Corp. as technical adviser on Air Force ballistic missile programs. It also may review air traffic control management from the standpoint of military and civilian integration and other military management plans; missile base construction problems, if other committees such as Appropriations do not probe this area; and mutual weapons development and U. S. investments in foreign defense firms and facilities.

Conflict of Interest Study Panel Named as Kennedy Fills More Jobs

Washington—Special panel to devise ways of strengthening conflict of interest laws without impairing recruitment of qualified personnel was appointed by President Kennedy last week.

Members are Baelis Manning, Yale University Law School professor and author of "Conflict of Interest in Federal Employment"; Jefferson Fordham, dean of the University of Pennsylvania Law School, and Judge Calvert Magruder, former chief judge of the First Circuit Court of Appeals, chairman.

Panel is to report its findings by Mar. 15. It also will be available to advise presidential appointees on specific ethical or conflict of interest problems. The President also named:

- **Carlisle Runge,** former assistant dean of University of Wisconsin Law School and now coordinator of university's national security studies group, assistant secretary of defense-personnel.
- **Paul B. Fay, Jr.** a San Francisco businessman, as under secretary of the Navy. Fay, an independent Republican who was in the President's World War II torpedo boat squadron, is vice president of a construction firm.
- **Kenneth BeLieu,** staff director of the Senate space committee and the Senate Preparedness Investigating Subcommittee, was appointed assistant secretary of the Navy for materiel.
- **Walt W. Rostow,** professor of economic history at the Massachusetts Institute of Technology, as deputy special assistant to the President for national security affairs.
- **Clarence D. Martin, Jr.,** Santa Monica, Calif. auto dealer and son of the former governor of the state of Washington, as under secretary of commerce for transportation.
- **Adam Yarmolinsky,** Washington lawyer and former law clerk for Justice Stanley F. Reed, U.S. Supreme Court, as special assistant to the Secretary and Deputy Secretary of Defense.
- **Cmdr. Tazewill T. Shepard, Jr.,** a son-in-law of Sen. John Sparkman (D.-Ala.), as Naval aide to the President; Brig. Gen. Chester V. Clifton, deputy chief of Army's office of information, as military aide; Col. Godfrey McHugh, deputy chief of the long-range objectives group in the Air Force's plans division, as Air Force aide.
- **New Presidential Science Advisory** Committee members for terms ending Dec. 31, 1964, are Dr. Paul M. Doty, Harvard University professor of chemistry; Dr. Jerrold R. Zacharias, Massachusetts Institute of Technology professor of physics; Dr. Harold Brown, director of the Lawrence Radiation Laboratory, and Dr. Frank Press, director of the seismological laboratory at California Institute of Technology.

McNamara's Bonus

Washington—Secretary of Defense Robert S. McNamara is due to receive $618,750 in bonuses for past service from Ford Motor Co. over the next six years, according to a statement filed with the Senate Armed Services Committee.

The total is payable in this sequence: 1961, $170,000; 1962, $157,000; 1963, $157,000; 1964, $85,750; 1965, $24,500; and 1966, $24,500. In McNamara's case, Ford waived a stipulation that former employes, in order to be eligible for earned bonus payments, must be available to the company for consultation.

McNamara will also be eligible to receive $1,315 a month at the age of 65 under the company's retirement plan.

He surrendered the right to exercise options to purchase 7,500 shares of Ford stock at $66 a share and 3,000 shares at $47. At Ford's current quotation of $60 a share, the potential profit was $99,000.

To avert a conflict of interest as Secretary of Defense, McNamara placed $1.1 million, after taxes, from the sale of Ford stock in a trust fund (AW Jan. 23, p. 37). He started at Ford in 1946 as assistant director of planning and resigned, after one month as president at a salary of over $400,000 a year, to accept the top Defense job.

Kennedy Extends Ban On U-2 Over Russia

Washington—President John F. Kennedy has assured the Soviet Union that U-2-type reconnaissance flights will not be resumed, but he declined to elaborate on whether this assurance was a concession for the release of two RB-47 crewmen returned after seven months in a Soviet prison.

President Kennedy announced release of the crewmen last week at his first news conference and called this Soviet action "removal of a serious obstacle" to improved East-West relations. He said his decision on reconnaissance flights is a continuation of the Eisenhower policy set last May after the U-2 incident.

The RB-47 was shot down July 1 over the Barents Sea, and the President said release of the U-2 pilot was not brought up in diplomatic discussions because of the distinction between the U-2 and RB-47 missions.

The Russians refused to verify a report that 11 American fliers missing in a C-130 flight two years ago are alive. President Kennedy said they were discussed, but Russia stands by its previous position—a disclaimer of knowledge about the crewmen.

President Kennedy said no one suggests that the Wiesner Group's report criticizing the space effort (AW Jan. 23, p. 79) is in every case right, but he called the group a "blue ribbon panel" made up of men with broad experience, free to make any recommendations they considered necessary to improve the national space program.

He said he hoped that a permanent administrator of the National Aeronautics and Space Administration would be appointed before the end of last week (see p. 21), and that he had appointed an acting administrator. Deputy Administrator Dr. Hugh L. Dryden has been acting administrator since Jan. 20 in normal succession following resignation of former Administrator Keith Glennan.

The President covered these other major points:

- **Nuclear test ban negotiations:** U. S. has requested postponement of the Geneva meetings from Feb. 7 until late March to allow time for a clear, strong position to be developed. Disarmament negotiations also depend on preparing a positive U. S. position.
- **Gold flow:** Alternatives are being studied to Eisenhower directive of Nov. 16 reducing number of overseas military dependents as a means of reducing the flow of gold from U. S.
- **Congo relief:** U. S. will airlift 1,000 tons of food and medical supplies to the African nation to relieve the current famine there.

Military Space Tracking Needs Outlined

By Larry Booda

Colorado Springs—First presentations of user requirements for a space detection and tracking system (Spadat) were made here last week by representatives of the military services and their principal unified commands at a conference called by Gen. Laurence S. Kuter, commander of the North American Air Defense Command.

The initial conference was national rather than international in character so that U. S. needs could be ascertained for the fledgling organization, which came into being last November when Norad was assigned the responsibility for military satellite detection and tracking. This work eventually will be integrated into an "aerospace" defense operation that would include satellite kill capability.

Kuter presided in his other capacity as commander of the Continental Air Defense Command. His Conad staff has been preparing plans for integrating all relevant sources of space information. First step in coordinating the planning was taken last month when Conad presented its own requirements at a meeting held at the National Space Surveillance Control Center at Hanscom Field, Mass. Participants were asked to prepare their own lists of requirements for last week's meeting.

National Aeronautics and Space Administration, although not officially a part of any military group, is also participating with the idea of obtaining information on its own and other nations' space vehicles.

Monitor for the Defense Department is USAF Lt. Gen. Donald N. Yates, deputy director of Defense Research and Engineering in charge of ranges.

The surveillance center, now operated by the Air Research and Development Command on a development basis and to gather elemental scientific information, is scheduled soon to become operational and will pass to Conad's control. Navy Space Surveillance (Spasur) network, with control headquarters located at the Naval Weapons Laboratory at Dahlgren, Va., will become operational Feb. 1. Gen. Kuter and Vice Chief of Naval Operations Adm. James S. Russell will participate in commissioning ceremonies. Both the surveillance center and Spasur will become integral parts of Spadat.

The Spadat organization now is small, with 15 Air Force officers and men from the Air Defense Command in training at the surveillance center. This nucleus will be used for future expansion and will be part of the over-all Command Operations Center of Norad. The planning staff at Conad-Norad consists of representatives of all U. S. military services.

The acronym Spadat will apply informally during the initial phases of organization until the system is integrated into the over-all air and space defense of Conad-Norad.

Plans for Spadat include making use of every type of sensing device including optical sightings. Inputs would come by radio, landline and mail. Some of the sensing systems which will be used were developed during the International Geophysical Year—for example, the network of Baker-Nunn telescopic cameras located in India, Australia, Japan, Hawaii, New Mexico, Florida, the West Indies, Peru, Argentina, Spain and Iran.

Network has been under the management of the Smithsonian Astrophysical Observatory. Cameras are capable of photographing faint objects and can fix the position of a satellite with considerable accuracy. Limitations of the system are that it cannot work through cloud cover, and the field of view is restricted. Usually the cameras must work with information obtained previously from other sources.

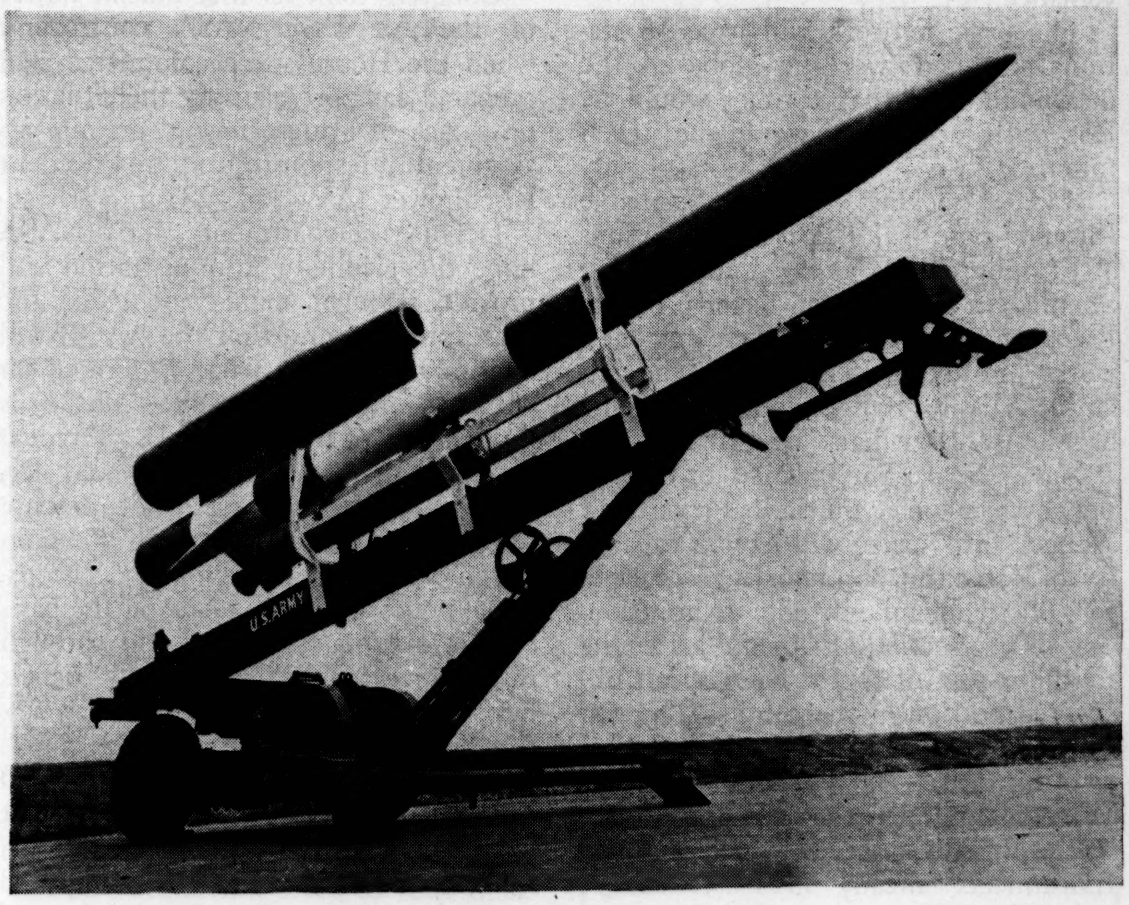
The Ballistic Missile Early Warning System also will be capable of sensing satellites that pass through its beams. Altitude limit for BMEWS, however, will be that for the highest part of the trajectory of a ballistic missile—about 800 naut. mi. Initial satellite detection altitude requirements will be about 3,000 mi. Future requirements will have to take into consideration probes and elliptical orbits out to 100,000 mi.

Minitrack System

One of the earliest space tracking systems was Minitrack. In order to be effective the Minitrack receiving stations had to receive a signal emitted by a satellite in the very high frequency range. By measuring phase differences in the received wave signals between stations, the position, path and speed of the satellite could be computed.

Minitrack eventually will be available for detection of nontransmitting satellites as well. A ground transmitter could illuminate the satellite and the reflected signal would be analyzed.

In conjunction with other radio receivers, the relatively new radio telescopes such as the one at Jodrell Bank, Manchester, England, and the new, larger one being built by the Navy in West Virginia, can be used for satellite



Army's Redhead-Roadrunner Target Missile

Full-scale dummy of U. S. Army's Redhead-Roadrunner target missile system (AW July 4, p. 37) simulates aerodynamic configuration and characteristics, weight, mass, center of gravity of actual missile, which will be flight tested for first time at White Sands, N. M., in March. Two test firings of dummy missiles were made in December to check rocket booster units, their line of thrust, and launch characteristics of system. Manufactured by North American Aviation-Columbus, missile flies subsonically or supersonically up to Mach 2, depending on mission. Speed at burnout of solid-propellant booster is Mach .9.

tracking. Jodrell Bank, with a 250-ft. parabolic antenna, can track a transmitting vehicle out to 40 to 60 million mi.

For tracking deep space probes, there is a network with receivers located 120 deg. apart over the globe. They are at Goldstone, Calif., Woomera, Australia, South Africa and Hawaii. Goldstone station was used for transmitting a message via the moon to the Bell Telephone Laboratories at Holmdel, N. J., a distance of 900,000 mi. There was a five second delay in the return of each signal.

An informal arrangement has been made by the surveillance center with Project Moonwatch, a volunteer organization that receives sighting information from members all over the world who own optical devices of 50 power or greater. Information is fed into a central office by telephone, telegraph or mail.

Mercury Network

Another tracking system that soon will be able to provide inputs to Spadat is the Mercury network, being constructed to track the man-in-space Mercury capsules when the program reaches the point where far downrange and orbital shots are made. The system will cover the entire detection and tracking spectrum, including optical sightings, radar, interferometers and space surveillance.

The basic network will have 18 stations scattered over the globe so the maximum time that contact would be lost with a vehicle would be seven minutes.

Radar tracking is now available through powerful FPS-17 installations at Ft. Churchill, Canada; Laredo, Tex.; Shemya, in the Aleutian Islands; Puerto Rico, and in Turkey. Tracking networks already in existence at the Atlantic Missile Range and the Pacific Missile Range will also be available.

Navy's Space Surveillance, or Spasur, network, which transmits a narrow "fence" into space, will have a capability of detecting non-radiating satellites to 3,000-naut. mi. altitude. It now consists of two sections of "fence" across the southern part of the U. S., with an uncovered portion in the center. The gap will soon be plugged with a 50-kw. CW transmitter which will be located at Wichita Falls, Tex. This transmitter will eventually replace the lower power transmitters already in existence. A data acquisition network will extend from Georgia to California. Information is fed into an "unmatched" computer located at the Naval Weapons Laboratory, Dahlgren, Va.

Miscellaneous inputs for Spadat will be received from private telescope owners and the larger telescopes operated by universities.

Cooperation Theme Is Stressed By NASA and Defense Officials

Washington—Top officials of the Defense Department and the National Aeronautics and Space Administration are deliberately stressing an atmosphere of cooperation, and they are promoting the high-level Aeronautics and Astronautics Coordinating Board as the most effective for continuing liaison.

In the early weeks of the new Kennedy Administration, top Pentagon and space agency officials appear anxious to counteract reports of a fight brewing between NASA and the Air Force over the assignment of space roles and missions. Former NASA Administrator Keith Glennan attributed a new spirit of NASA-military cooperation to AACB just before he left office, and NASA, USAF and Defense officials continue to urge the theme of cooperation.

Despite this peaceful facade, the Air Force is continuing its drive for a larger share of the national space program. First official discussion of the USAF campaign came when Air Research and Development Commander Lt. Gen. Bernard A. Schriever described USAF plans for expanding its role to the American Astronautical Society (AW Jan. 23, p. 32).

Congress took its first official notice of the Air Force-NASA controversy when the House space committee staff prepared a report blaming the situation on a lack of leadership and definite assignment of responsibilities by President Eisenhower (AW Jan. 23, p. 33).

Defense Department and NASA hope the Kennedy Administration will provide stronger management for the space program and that the AACB will continue to reflect what is termed an effective means of liaison. AACB is headed by Dr. Hugh L. Dryden, deputy NASA administrator, and Dr. Herbert F. York, director of defense research and engineering, both of whom are empowered to make policy decisions.

All policy decisions made on the basis of information exchanged and through discussions of AACB and its panels have been accepted by the two agencies. Machinery to appeal board decisions through the Defense Secretary and NASA administrator to the President has so far been unnecessary.

Some board decisions have required surrender of functions, and most of them are obvious attempts to avoid duplication and cut costs. They include:

- **Booster development** and procurement is done by a single agency for each major launch vehicle. NASA will continue development of Saturn, Centaur and Scout both for civilian and military activities. Air Force has this responsibility for Atlas, Thor and Agena, and the Army for Redstone.
- **Tracking net joint use** has been arranged for development of Centaur and the Advent communications satellite. NASA plans to use its worldwide net for the first six Centaur development launches, but will shift to DOD, the operational Advent net as soon as it is ready. This could be as early as the fourth Centaur development flight, scheduled in about a year.
- **Responsibility for releasing** scientific orbital information has been assigned to NASA. This previously was done by NASA, the Air Force through its Spacetrack facilities, and the Navy through its satellite detection net.
- **Pad construction** and modification will be designed and funded at the Atlantic Missile Range jointly by NASA and the Air Force.

The over-all liaison system has been reorganized, eliminating seven committees and absorbing functions they performed in the AACB panels.

The long-dormant Civilian-Military Liaison Committee, existing by statutory requirement of the 1958 Space Act, has not met since December, 1959, nor had a chairman since William M. Holaday's resignation last April. The AACB informally filled the void until it was made the official liaison group Sept. 13.

Elements eliminated by board review were the NASA-Advanced Research Projects Agency Manned Satellite Panel; Defense Department Advisory Committee on Communications Satellites; Interim Saturn Committee; ARPA Recoverable Booster Panel; NASA-Defense Space Sciences Committee; NASA-Defense Advisory Committee on Bioastronautics and NASA-Defense Committee on Space Flight Ground Facilities.

The manned satellite panel was active preceding assignment of Project Mercury to NASA's Space Task Group, but then did not meet for over two years. The communications satellite group also was established by ARPA and was inactive. The Saturn panel functioned while the booster was being transferred from Army to NASA.

AACB panels are Manned Space Flight, which includes joint life sciences discussions; Unmanned Spacecraft, including space sciences, communications and weather satellites; Launch Vehicles, with a Centaur management group and a Scout coordinating element; Space Flight Ground Environment; Supporting Space Research and Technology, and Aeronautics.

MR-2 Capsule to Carry A 40-lb. Chimpanzee

Washington—A 40-lb. chimpanzee will be flown in the second Mercury-Redstone capsule to qualify the life support system and provide a measure of performance ability during 4.5 min. of weightlessness.

The test is scheduled this week, and if successful, it will set the stage for manned ballistic flight in the third Redstone-boosted capsule, which could be launched this spring.

Flight trajectory will be flatter than the profile for MR-1, launched Dec. 16 to test the combination of production capsule and Redstone booster (AW Dec. 26, p. 16).

In addition to first qualification of the environmental system, MR-2 will be the initial test of the booster abort sensing system on a closed loop, first use of the impact bag to attenuate landing shock, and first use of the Project Mercury control center.

MR-1 flight had an altitude of 130 mi. and a range of 235 mi.; MR-2 will be programed to a 115 mi. altitude, with an impact range of 290 mi. This trajectory will reduce forces from 12g to 11g.

The chimpanzee, 42-48 months old, will be carried in a pressurized chamber, restrained on a contoured couch. The flight animal will be selected from among six which have been at Cape Canaveral several months and will perform a psychomotor shock-avoidance test during the flight. Mercury chimps have been trained by the Air Force at the Aeromedical Field Laboratory, Holloman AFB, N. M.

A movie camera will record the chimpanzee's reactions, and a second camera will record the instrument panel during flight.

The MR-2 flight sequence program essentially duplicates the MR-1 flight. The Redstone has about 2.5 min. burning time, during which it reaches a 34-mi. altitude and 4,000 mph. velocity. At burnout, the escape tower is jettisoned and three posigrade rockets ignited for booster separation. Oscillations are damped by the automatic stabilization and control system. Five seconds after separation, the autopilot reorients the capsule 180 deg. so that blunt end is forward.

Near apogee, control jets push the blunt face 35 deg. above the horizontal plane, and at apogee three retrorockets are ignited and the rocket pack jettisoned.

The autopilot then will orient the capsule in a shield-down attitude for re-entry. Drogue chute will deploy at 21,000 ft. and main chute at 10,000 ft.

Heat load on the Redstone capsules is about 100F on the beryllium shield and 250-300F on the afterbody. Atlas capsules will use an ablation shield which will experience 3,000F loads.

The MR-2 capsule contains four telemetry channels, each with a backup. Two channels will transmit heart rate, the third respiration, and the fourth data measurements on structural heating, cabin pressure and temperature, noise and vibration. The data channel will be linked to 90 sensors in the capsule. Electronic systems are powered by silver zinc batteries.

The MR-2 experiment is the first under the new National Aeronautics and Space Administration policy to provide official information prior to a launch.

Previously, official information on space flights was embargoed until launch (AW Jan. 2, p. 15).

USAF Plans Reverse Airlift From Congo

Wiesbaden—U. S. Air Force is laying tentative plans for a reverse airlift from the strife-torn Congo, ferrying out the troops of dissatisfied nations that it had flown into the republic during the initial crisis late last summer.

One country, the United Arab Republic, already has ordered its 519-man contingent withdrawn to protest United Nations refusal to forcibly restore deposed left-wing Premier Patrice Lumumba to office. Other African nations probably will follow.

As of late last week, no formal order for a UAR airlift had been received at U. S.-Air-Force's-in-Europe headquarters here, but it was expected, and officials were tentatively planning to begin the move by mid-February.

In announcing the decision to withdraw its troops, the UAR last week demanded that they be returned from the Congo by Feb. 1. It is doubtful, however, that the deadline can be met.

The airlift of the UAR troops, and those of any other nations following suit, would only be made by USAF at United Nations request.

Meanwhile, the 322nd Air Division, headquartered at Evreux, France, which last summer spearheaded the transport of troops into the Congo, has begun an "anti-famine" airlift in an effort to help resupply the destitute republic.

Airlift began last week as four Lockheed C-130 turboprop transports ferried 100 tons of dried fish over the 4,000-mi. route from Flesland, Norway, to Lulaburg. In all, more than 1,100 tons of foodstuffs are scheduled to be flown in from Norway and four African nations by C-130s and Douglas C-124s of the Military Air Transport Service.

News Digest

Navy Bureau of Ships will design and develop equipment for a shipboard satellite communications terminal capable of communicating with two Army shore stations through the Army's Advent communications satellite.

Lockheed Aircraft Corp. has a $100,000 National Aeronautics and Space Administration contract to study spacecraft rendezvous techniques (AW Nov. 7, p. 26). Space Technology Laboratories is subcontractor in the six-month project.

Dr. George B. Kistiakowsky, former scientific adviser to President Eisenhower, accepted the chairmanship of Itek Corp.'s Itek Science Board last week. Kistiakowsky replaces MIT Prof. Jerome B. Wiesner, special assistant for science and technology in the Kennedy Administration (AW Jan. 16, p. 29).

Beech Aircraft Corp. total sales in Fiscal 1960 were $98,873,800, a 10.4% increase over the same period the previous year. Business and commercial aircraft sales reached an all-time high of $46,570,254, up 22% over Fiscal 1959 and military sales equaled the previous year's volume. Net income in Fiscal 1960 was an all-time high of $4,854,059, equal to $5.41 per share, an increase of 22.3% over Fiscal 1959.

Navy has awarded an $8.3-million contract to Westinghouse Electric Corporation for production of the radar portion of the air missile control system of the McDonnell F4H-1.

Modified Pratt & Whitney J57 turbojet engine will turn an electrical generator for Hartford (Conn.) Electric Light Co. during peak load hours, producing from 8,000 to 10,000 kw. Regular jet fuel will be used.

Halaby Electra Flight

Los Angeles—Najeeb E. Halaby, Kennedy Administration Federal Aviation Agency administrator, was to fly the Lockheed Electra late last week as part of a personal review he has been conducting of the Electra modification program.

Halaby said he is convinced that all necessary modifications of the airplane have been completed but that he wanted to assure himself first-hand that the aircraft is ready for airline duty. He said he planned to fly the Electra "up to and beyond the conditions the public will fly in it."

Excess Seat Problem Will Grow This Year

Jet deliveries to expand trunks' surplus capacity, which depresses load factors, utilization rates.

By L. L. Doty

Washington—Excess capacity problems, which plagued the domestic trunkline industry during 1960 and held its annual profit to the lowest level since 1949, are now expected to continue through 1961.

As first predicted by Aviation Week (Dec. 28, 1959, p. 28), a slight increase in revenue passenger miles during 1960 was rapidly outstripped by a persistent rise in available seat miles, depressing the industry's average load factor and its aircraft utilization rates. Scheduled delivery of more than 100 additional turbojet transports during 1961 will magnify the surplus seat problem and threaten continuation of the steady drop in load factors that began eight months ago.

Revenue passenger miles during 1960 fell off sharply month-by-month to culminate in a modest 4% increase for the year, compared with a 15% jump in 1959. The dwindling traffic figure was most pronounced in November and December when revenue passenger miles showed 3% and 4% decreases respectively.

Available seat miles rose steadily during the year, although the upward trend was arrested in November and December when the monthly volume was held at an almost constant level. Nevertheless, in each of the two months, the industry load factor took its worst drop of the year.

Unrealized Potential

The current situation suggests that the domestic trunkline industry is not achieving the full utilization potential of its fleets. In addition to retiring a number of piston-engine aircraft into inactive status, the industry had held utilization of its turbojet fleet to approximately 8 hr., a figure which includes such activities as flight training and charter operations. Highest rate has been attained by Continental Air Lines, which has averaged a 10.58-hr. utilization since it began service with its Boeing 707 fleet.

During 1962, when only a small number of jets are scheduled for delivery, the industry will have a short breathing spell during which the gap between traffic growth and capacity increases can be narrowed.

In 1963, however, the problem will loom again when production of medium-range jets will create a new rash of aircraft deliveries for scheduled service.

The national economy may rebound early this year from the economic recession of the past six months and promote a resumption of normal traffic growth. As previously pointed out (AW Feb. 28, p. 38), airline business is extremely sensitive to the fluctuations of the Gross National Product, which, after a 15% increase in the first quarter of 1960, fell 1.5% in the third quarter and showed no change in the final quarter of the year.

In view of the GNP trend last year, coupled with a decline in personal income in the last half of 1960 and a decided drop in corporate earnings beginning early in the year, airline traffic made a remarkably strong showing during 1960. Contrasted with 1960's 4% gain, revenue passenger miles suffered a 0.3% decline during the recession year of 1958.

Industry's Future

This record suggests that should the general economy resurge early this year, airline traffic growth may be quickly restored to prevent a further depression of load factors. Thus, the immediate future of the trunkline industry depends on an early general economic recovery, plus continued attempts to generate new traffic and a reshaping of the present pattern of airline routes—a move that began last year with the proposed merger of Capital Airlines into United Air Lines.

First class revenue passenger miles were hit hardest by 1960's traffic recession. Volume for the year declined 6%, and in only two months of the year did first class revenue passenger miles register an increase. The drop in December was 19%, in November it was 16%.

As a result, the industry was forced to curtail first class capacity severely. By the end of 1960, available first class seat miles for the industry had declined 0.7%. This reduction began in June when, for the first time, the volume of coach seats sold accounted for more than 50% of all seats sold. In October, first class traffic returned to its dominant position by a small margin.

First class load factors have declined consistently for the last 15 months. In December, the industry first class load factor dropped 4.4 points to a low 51%, compared with a 1959 average of 60%. First class load factor for 1960 was only 56%, compared with 59% for all types of traffic.

Coach Growth

On the other hand, coach traffic continued to climb spectacularly, failing by only a fraction to match first class traffic in revenue passenger miles for the year. Coach traffic showed a 17% gain for the year with a 63% load factor, despite a 19% increase in available seat miles. However, one disturbing factor appears in the coach record: load factors, while relatively high, registered an increase in only four of the last 14 months.

Generally, it is difficult to pinpoint the traffic depression to any particular market or geographical area with one exception: carriers serving the Florida market from East Coast business centers have consistently failed to generate sufficient traffic to maintain high load factors. Traffic activities of other trunklines vary widely.

An analysis of airline business during December, for example, shows that only three of the 12 trunklines were able to report an improvement in revenue passenger miles over December, 1959. United led the industry with a 30% increase in total revenue passenger miles. The airline reported a 60% increase in coach traffic and a 3% increase in first class traffic.

Braniff ended the month with a 4% traffic gain. The carrier's emphasis on coach traffic since its acquisition of turbojet equipment is illustrated by a 107% increase in coach traffic coupled with a 21% decline in first class traffic. In contrast, Delta reported a 16% rise in first class business compared with a small 4% coach increase for a total 10% gain in all categories of traffic.

Because of its current engineer strike, Northwest Airlines' business fell off 23% and available seat miles were sliced by 20%.

American experienced a 7% decline in over-all revenue passenger miles, with a 25% decrease in first class traffic and a 22% increase in coach traffic. However, the airline ended the year with a 12% increase in total revenue passenger miles over 1959. American says the 6.4-billion revenue passenger miles flown in 1960 is a world record.

Effect of turbojet equipment on seat productivity is illustrated by American Airlines' experience during two full years of Boeing 707 operations. During that time the carrier's 707 fleet carried 2.8-million passengers a total of 4.8-billion passenger miles. By contrast, it took close to four years to accumulate the same traffic totals with the airline's fleet of 58 Douglas DC-7 transports—almost twice the size of the 707 fleet.

Big four carriers—American, Eastern, TWA and United—were generally more successful during December than the eight smaller trunk lines. Revenue passenger miles of the larger carriers declined only 2%, available seat miles rose about 4% and load factor fell from 60% in December, 1959 to 57% last month.

The smaller airlines reported an 8% dip in revenue passenger miles, a drop of 6% in available seat miles and a decline in load factor from 54% to 52%. The eight airlines showed a 2% increase in coach traffic, compared with a 26% increase in coach traffic registered by the Big Four.

Big question mark in the immediate future is the value of the Florida market to the seven trunklines which now serve the area with turbojet equipment. Eastern, National and Northeast, closely competing for traffic on East Coast routes into Florida, continued to report load factors substantially below the industry average. Although Eastern experienced a 11% decrease in revenue passenger miles in December, available seat miles were sliced 14% to raise the monthly load factor from 49% to 50.3%. National's load factor dropped two points to 50.9%, since a 12% reduction in available seat miles was offset by a 16% drop in revenue passenger miles. First class traffic of both carriers declined sharply, while coach traffic remained fairly stable.

Northeast Airlines, with a 47% load factor—down one point from December, 1959—reported a 5% decrease in revenue passenger miles. The carrier's first class traffic jumped 20%, but coach traffic was down a severe 20.6%.

Although Continental's load factor fell from 53% in December, 1959 to 47% last year, the carrier's traffic dropped only 5%. Coach traffic was up 18%, but first class dipped nearly 16%.

TWA, which has had a 9.5-hr. daily utilization record with its Boeing 707-320 turbojet fleet and is now operating 54% of its schedules with jets, experienced a 15% decline in traffic during December. Capital Airlines reported a 7% increase in coach traffic during the month, but a 20% dip in first-class business gave the airline a 14% loss in all types of traffic handled.

There is a tendency to consider last month's midair collision over New York (AW Dec. 26, p. 26) as the chief reason behind December's poor record. Although it has been fully demonstrated that highly-publicized accidents have a decided but short-term affect on airline business, the December record appears to most observers to be a normal sequence to the dismal showing in November when traffic fell 3% and load factors dropped 2.7%.

Net result of the current situation will be continued stress on sales, marketing techniques and new means of generating traffic, all of which will intensify competition that has already reached a heated level. Services to passengers, source of one of the most rapidly growing cost factors in 1960, will be accelerated this year and will draw heavily on the resources of individual carriers. These heavy expenses, stemming from growing competition together with equipment transitional costs which are not leveling off as anticipated when jet services were first launched, will place new fiscal demands on an industry which generally has been denied the benefits of withheld profits as a means of bolstering working capital.

As a result, 1961 will undoubtedly prove to be a continuation of the transitional phase which began in late 1959 when the first visible signs of the need for mergers started to appear. Few carriers can run the risk of low load factors for an extended period of time, and most officials of major carriers have felt for some time that mergers are an inevitable solution to the financial problems some carriers are expected to meet during the next two years.

Despite the rash of merger rumors which persist throughout the industry, there are no firm discussions on mergers between any of the trunklines at this time other than the proposed consolidations of United with Capital and TWA with Northeast.

Rolls Modifies Tyne Disk

London—Failure of Rolls-Royce Tyne turbine disks, which was due to an obscure metallurgical problem, has forced Rolls-Royce to change the manufacturing process for the disk and to scrap 3,500 disks made prior to the incident (AW June 6, p. 43).

The disks involved included not only the last two high pressure compressor stages but all the turbine disks as well. The possibility of reworking the forgings was considered but was ruled out.

In the new process, both the disk profile and the material, ferritic stainless steel, REX 535, has been retained but the ductility has been raised nearly 15% by improving the steel quality and ensuring more hot working and better grain flow during reduction of the blank. Heat treatment techniques also have been modified.

The purity of the metal has been improved by switching to vacuum melting of the stock material, and the better grain flow has been achieved by considerably increasing the length-to-diameter ratio of the billet so that the reduction of the billet during forging involves more hot working. The forging program itself has been revised.

The failure proved to be one of the most perplexing problems that Rolls has encountered, finally reducing to a statistical problem involving scatter factors of the physical properties of the material. Although the decision was finally taken to scrap all the original disks, the statistical analysis predicted that less than one in 200 of the disks would be affected.

Major Tyne setback followed bursting of a disk on a testbed last May after 21,000 hr. of engine testing, including a comprehensive program of testing at overload conditions. It coincided with the final stages of the route-proving trials of the Tyne-engined Vickers Vanguard and came within a few days of the aircraft's certification (AW Dec. 5, p. 41).

An inspection of every engine that had flown revealed one other disk with a crack radiating from the bore—with virtually the same origin as the burst disk—and all Vanguards were grounded.

Stringent investigations of the turbine disks followed, and "short life" engines were made available so that flight test programs with the aircraft could proceed.

Because the failure was difficult to reproduce, the investigations were protracted. Rolls' management decided to consult world experts and consultants from engine manufacturers, steel alloy makers and research centers before confirming the statistical nature of the problem.

Compressor and turbine disks are now in full production, using the new techniques and are being fitted to all new engines and as replacements for those engines running with short life disks. Engines with the new disks and modified up to the latest standard are now being delivered for installation in Vanguard and Canadair CL-44 aircraft.

U. S. Foreign Air Policy Radically Revised

Washington—President Eisenhower's last minute decision in the controversial transpacific route case indicates that the Kennedy Administration has inherited a drastically revised U. S. international aviation policy, one that calls for negotiating bilateral air transport pacts on diplomatic rather than economic bases.

The executive decision, an abrupt switch from the position the U. S. has held since the first major bilateral agreement was signed with Britain in 1946, brought to a close the highly expedited transpacific case with virtually no route structure changes in the entire Pacific area. President Eisenhower issued the decision less than 24 hr. before he left office.

If the new policy stands, it will mark a victory for a number of foreign flag carriers who have urged their governments to make bargaining for new routes to the U. S. an affair of state rather than an economic transaction. The possibility of such a policy change was first predicted by Aviation Week (AW Jun. 13, p. 38).

How strong an effect the Eisenhower action will have on the new administration is still a matter of conjecture since it is undoubtedly too early for President Kennedy to evaluate the decision. It is the prerogative of the new President to order the CAB to review transpacific routes for his consideration, but such a move does not appear likely within the immediate future.

Foreign Pressure

However, Kennedy will be subjected to the same pressures, if not stronger, that were applied to the Eisenhower Administration by foreign governments seeking new air routes to and through the U. S. on a diplomatic level. For example, it has been reported that British Prime Minister Harold Macmillan brought up the subject of international air routes in recent discussions with President Eisenhower. Issues raised to this level will naturally force the new Administration to formulate some basic policies to guide it in forthcoming bilateral negotiations.

In his original letter to the CAB—dated Feb. 18, 1959—calling for a Board review of the Pacific route complex, Eisenhower said his Administration "is firmly committed to the view that the public interest requires competitive American flag service at the earliest feasible date on all international air routes serving major United States gateways." He added:

"Over the North Atlantic our objective has been substantially achieved, but in the Pacific, because so far it has not been deemed feasible, very little progress in the desired direction has been made."

In his letter of Jan. 18, in which he disapproved Board route recommendations with minor exceptions, he stated that his decision was "predicated solely on considerations of foreign policy, a responsibility that is mine and which the Board, of course, does not share."

Damages Foreign Relations

He noted that the addition of new carriers on the route would affect foreign relations "adversely." Increased capacity, he said, should not be approved unless traffic forecasts show that such capacity can be absorbed without "engendering a legitimate fear abroad" that U. S. carriers would absorb so much business they would hurt foreign flag carriers economically. He concluded that the approval of the Board's recommendations "would unsettle our international relations—particularly with Japan, which would be faced with an additional United States carrier on all but one of the now existing four routes from the United States to Tokyo."

The clearly stated policy is a direct corollary to Eisenhower's decision to grant a Los Angeles route to KLM as a result of high-level Dutch government insistence that failure to give the airline such a route would strain relations between the two countries. State Department earlier had adamantly refused to award the route to KLM on grounds that such an operation would not be economically sound.

A Treasury Department warning that granting of the KLM route would only serve to compound the currently unfavorable U. S. balance of trade caused Eisenhower to reverse his decision in the case. Although it has not yet been officially reported, Aviation Week has learned that Italy has been given a route to Los Angeles under the terms of a renegotiated bilateral because of the high volume of traffic flying between the U. S. and Rome.

Eastern to Lease 720s

New York—Eastern Air Lines has arranged to lease 10 Boeing 720s from the Prudential Insurance Co. instead of buying the jets from the manufacturer.

Under the arrangement, Prudential will purchase the 10 720s and turn them over to Eastern on a 10-year lease. The airline had originally ordered 10 of the 720s from Boeing and later boosted the total to 15. The additional five airplanes will be purchased directly by Eastern. Most of the 15 planes will be delivered this year.

The deal, negotiated for Eastern by Kuhn, Loeb and Co. and Smith, Barney and Co., involves a purchase price of $47,750,000 for 10 720s and 20 spare engines.

Eastern expects the first airplanes it will buy directly to be financed through cash flow and not to involve financial strain. The lease assures financing for the other 10 planes without straining the airline's resources.

The recent report issued for the White House by United Research Corp. on international air transportation (AW Dec. 19, p. 40) undoubtedly had a strong influence on the final Eisenhower decision on Pacific routes. The report recommended the use of a traffic formula as a determining factor in deciding how many carriers should be assigned to each long-range international route.

Traffic Formula

Traffic currently available to U. S. carriers on transpacific routes is less than that set in the United Research formula as the dividing line between one and two airlines.

The case itself was rushed through to a final decision by the Board with almost unprecedented speed. In the words of one airline attorney, "we found procedural deadlines, at times, to be almost unreasonable." In the final decision, each member of the Board dissented on one or more points.

Because Eisenhower disapproved the international phase of the Board's decision, the Board decided "to give further consideration to the domestic phase of this proceeding, and for that purpose, to stay its decision . . ." Under the decision, Western Air Lines would have been added as a new carrier between the West Coast and Honolulu.

Here are the segments of the Board's recommendations which Eisenhower approved and which the Board subsequently ordered into effect:

- **Northwest Airlines'** authority renewed indefinitely to serve Okinawa, Korea, Taiwan, Hong Kong and the Philippines.
- **Pan American World Airways'** authority renewed indefinitely to serve Japan, Viet Nam, Singapore, Sumatra, Java, Malaya, Thailand, Burma and points within India and Pakistan lying north of the 20th parallel.
- **Pan American's** certificate amended to redesignate Australia as an intermediate point and adding Java as a new intermediate point on its South Pacific route.
- **South Pacific Air Lines'** temporary certificate renewed for a period of five years, its certificate amended to re-

Convair 990 Coronado Makes First Flight

Convair 990 Coronado jet transport made its first flight Jan. 24 at San Diego, Calif., with chief engineering test pilot Don Germeraad at the controls. Plane was taken to 25,000 ft. after clearing the runway in 3,500 ft.; flight lasted 2 hr. 3½ min. The Coronado is powered by four General Electric CJ805-23 aft fan turbojets and is designed to cruise at 640 mph. (AW Dec. 5, p. 42). A second Convair 990 (formerly designated the 660) is being static tested in the San Diego structures test laboratory, for checks on loading of fuselage, wings, engine pods, gear and control surfaces.

designate the terminal point Society Islands as an intermediate point on a new route to the terminal point Fiji via American Samoa and Western Samoa, plus authorization to carry mail on a nonsubsidy basis.

- **Trans World Airlines'** certificate amended to authorize service beyond Bangkok to Hong Kong and its authorization to serve Manila renewed.

If the original CAB decision had stood, Northwest Airlines would have won a new route from Boston, New York, Philadelphia, Washington/Baltimore, Detroit and Chicago to Tokyo via Honolulu. The East Coast cities would also have been coterminals on its existing route to the Far East via Anchorage. San Francisco and Los Angeles would have been added as coterminals with Seattle and Portland.

Pan American's certificate would have been amended by adding New York as a coterminal point with San Francisco and Los Angeles on the central Pacific route and by the authorization of service to intermediate points within Java.

A new route segment would have been granted the carrier from the terminal point New York via Fairbanks, Alaska and intermediate and terminal points within Japan subject to a condition that would prohibit single-plane service between Seattle-Tacoma and points west of Honolulu via Fairbanks.

BUA Plans $55-Million Jet Fleet

London—British United Airways, largest British independent airline, will spend about $55 million on jet airliners if applications are granted for a new range of scheduled services, nearly all of which would duplicate existing services by other British airlines.

The jet fleet would consist of "four long-range aircraft such as the VC 10 [and] five short-range aircraft such as the DH Trident," says BUA, which is pledged to buy British aircraft.

BUA has applied to the Air Transport Licensing Board for permission to run 17 year-round services to European centers, 13 seasonal vacation routes in Europe and five long-haul services to Khartoum, Lagos, Johannesburg, Singapore and Hong Kong. All but three of these routes are already served by either British Overseas Airways Corp. or British European Airways. BEA has confirmed that it will oppose the applications and BOAC's attitude—currently "under consideration"—is likely to be similar.

This move by BUA is the first major attempt to take advantage of the new freedom granted to British independents last February under the Civil Aviation (licensing) Bill which abolished BOAC and BEA monopoly rights to scheduled services. Outcome is uncertain because powerful influences are pulling both ways. British aircraft manufacturers are hungry for orders and would feel refusal of the license applications a betrayal, but BEA and BOAC would not appreciate the cream being skimmed from their operations. One BEA spokesman said that if the applications were granted, the airline might be forced to cancel some of its own orders—notably for DH Tridents.

In a letter circulated to all members of Parliament, BUA states that granting its requests would have "no effect whatever on the existing scale of operations of BEA and BOAC. . . ."

All FAA Development Now Assigned to BRD

Washington—Federal Aviation Agency's Bureau of Research and Development has been given full responsibility for all modifications, improvements, testing and direct support activities on existing air navigation, traffic control and communications facilities, adding to its previous responsibilities for research and development of equipment and techniques.

The action, taken by FAA Administrator Quesada just before leaving the post, is intended to better define an area of overlapping responsibility which had existed between the Bureau of Research and Development and the Bureau of Facilities and Materiel. The latter will continue to purchase, install and maintain equipment and facilities operated by FAA, except for prototypes of new equipment, which will be purchased, installed and evaluated by BRD.

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M. J. McDonough

UNSOLICITED IN-FLIGHT LETTER FROM M. J. MC DONOUGH EQUIPMENT SALES DIVISION, AMERICAN CAN CO.

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Trunks Oppose United-Capital Merger

Washington—Major trunk airlines last week warned the Civil Aeronautics Board that the proposed merger between Capital Airlines and United Air Lines would divert large amounts of business and saturate major routes.

Testifying before the Board in oral argument, several carriers agreed that approval of the proposed merger on an all-or-nothing basis would be disastrous, creating losses in now-profitable operations.

Northwest Airlines and Continental Air Lines both said the effect the merger would have on them would be heavy diversion of traffic and revenues, which would place them in a precarious competitive position. Northwest said the annual diversion loss it would experience would be $9.5 million, and Continental said it would lose $670,000 yearly. Both airlines said that approval of such a merger could create a trend toward absorption of smaller trunk carriers by the large airlines.

National, Eastern and Delta asked the Board to keep United out of long-haul markets currently served by them in competition with Capital. They added that such competition actually does not now exist because Capital has stopped providing really competitive service. Delta took the position that entry of United turbojet transport competition in the New York-Atlanta-New Orleans markets would oversaturate that route to the point where one of the carriers would be forced to abandon operations, hinting it might be Delta.

Eastern asked that United be kept out of the New York-New Orleans and Atlanta-Florida markets. Otherwise, according to Eastern's figures, there would be a diversion of at least $10 million annually. National specifically asked the Board not to award routes to United that it was denied when Capital was given authority to fly from Buffalo to Florida. National said transfer of such routes to United would seriously hurt carriers now operating in that area.

Two local service carriers, Allegheny Airlines and Mohawk Airlines, asked that United be kept off routes in which they are now well established. Allegheny wants to block transfer of Capital's authority to United on the New York-Harrisburg, Philadelphia-Pittsburgh, Harrisburg-Pittsburgh and Pittsburgh-New York routes. The local carrier said that it realizes the greatest amount of its revenues from these markets.

Mohawk said it would lose a substantial amount of revenue if United were permitted to operate on the Buffalo-Detroit route which Mohawk now operates. The carrier also said if such revenue losses were permitted, it might have to ask the Board for more federal subsidy.

Labor unions involved in the merger proceedings expressed dissatisfaction with employe-protective provisions. Air Line Pilot's Assn. and Air Line Stewards and Stewardesses Assn. said it would back down from its former demand that discharged employes be paid 100% of his average salary for five years and would accept a provision that would guarantee the employes 100% for one year and 60% for the remaining five years.

ALPA-ALSSA also raised the question of when the discharge of an employe would be "solely due" to the effects of the merger as cited in the examiner's decision. The union asked if changes in equipment, management and company policy would be the effect of the merger and asked for a firm statement from the Board on this subject.

Flight Engineers International Assn. said the three year length of employe job protection, set down by the hearing examiner and agreed to by United, is inadequate. FEIA said it should be extended to five years since major problems of turbojet transport acquisition will not come into being until 1963 or 1964, after the agreed period will have elapsed. The Brotherhood of Railway Clerks also asked for an extension of the period, but did not specify how long.

Terminal Area Jet Speed Limits, Mandatory DME Planned by FAA

Washington—Terminal area speed limits for jet transports and better traffic control training for United Air Lines pilots, plus a move toward requiring distance measuring equipment on all airline transports, are the Federal Aviation Agency's initial plans for improving the air traffic control system in the wake of the Dec. 16 midair collision over New York.

FAA will propose a rule setting a speed limit in terminal area operations for jet transports and will "emphasize the need for material on ATC procedures" in pilot training courses given by United, operator of the DC-8 which collided with a Trans World Airlines Constellation.

FAA also has initiated action on a rule proposed to require DME on all airline transports (AW Jan. 2, p. 26). These moves were revealed in a letter from former FAA Administrator E. R. Quesada to Civil Aeronautics Board Member Joseph G. Minetti, written just before Quesada left office with the Eisenhower Administration.

Referring to CAB's eight-day public hearing aimed at uncovering the accident's cause, Quesada also said: "The testimony of United Air Lines' representatives revealing their lack of understanding of the air traffic control environment . . . is indeed cause for alarm."

As a result, he said, "we will emphasize the need for material on Air Traffic Control procedures in pilot training courses given to pilot personnel of United Air Lines." The United Douglas DC-8 flew 11 mi. beyond its clearance limit before colliding with the TWA aircraft over Staten Island (AW Jan. 16, p. 38).

Quesada's letter was a written rebuttal to charges leveled at FAA by Charles F. McErlean, vice president-law for United, who said minutes before the public hearing adjourned:

"At this time we think it can be safely said that this accident would not have happened had Air Traffic Control properly utilized the equipment, personnel and facilities available" (AW Jan. 23, p. 49). McErlean went on to urge all those interested in aviation safety to assist in formulating measures that would improve the system.

On this point, the Quesada letter stated that DME has been available at Idlewild Airport, the United DC-8's destination, for over two years and that there are 343 other stations throughout the U. S. offering this feature. Although the military has 13,000 aircraft equipped with DME, United has only two, Quesada pointed out.

Because civil jets might avoid "overrunning clearance limits" with positive and continuous position information displayed in their cockpits, Quesada said the FAA "has initiated action looking toward the possible adoption of a rule requiring airline operators to equip themselves in a manner capable of utilizing existing DME facilities."

In view of traffic congestion around metropolitan terminals, Quesada said, pilots must be prepared to hold, divert, or turn to a vector without prior notice from ground controllers. This they can only do if speed permits such maneuvers within the terminal area.

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PRATT & WHITNEY AIRCRAFT DIVISION
EAST HARTFORD, CONNECTICUT

ALTA Asks Reduced Trunk Competition

Washington—Elimination of trunkline competition over local service routes was urged by the Assn. of Local Transport Airlines last week in a detailed subsidy reduction proposal submitted to the Civil Aeronautics Board.

Criticizing the trunkline practice of financing unprofitable short-haul segments with long-haul profits, the ALTA plan, prepared by United Research, Inc., suggested the industry's mounting subsidy bill could be reduced in this way:

- **Local service operators** should be given exclusive control over traffic into an estimated 100 low revenue producing communities now being served by a combination of local and trunk carriers.
- **Heavily subsidized** operations into 280 other points served only by local service airlines should be continued as a reasonable investment of public funds.
- **Subsidy payments** should be tailored to a uniform formula permitting local service managements greater latitude to experiment with different fare levels and achieve lower operating costs.

Overlapping of trunk and local service frequencies at the 100 cities has resulted in unnecessary duplication and uneconomical operations, requiring a local service subsidy of about $10 million annually plus "cross subsidization" by the larger airlines, the ALTA report stated.

Eliminate Restrictions

Removal of the trunks from these points would be accompanied by elimination of current route restrictions which force local service operators to stop at uneconomical intermediate points as a means of protecting a competing trunk carrier. Such restrictive measures, the study pointed out, amount to CAB judgments that the "possible penalty" of two carriers operating without restrictions along a route exceeds the "very probable penalty" of requiring one to operate uneconomically.

Final determination of service patterns should properly be made by airline managements on the basis of community needs, ALTA said, since the present CAB policy permits the Board to withhold subsidy support for any losses resulting from management error.

Recommending that local service subsidy payments for these 100 points be continued until the short-haul carriers are relieved of current operating restrictions, ALTA noted that the areas are essentially "natural monopolies" capable of supporting only one carrier.

Existing service to nearly 280 smaller airports, served only by local service airlines, requires an annual subsidy bill of more than $12 million, the report said, but this should not be considered excessive because of the advantages provided by feeder air service over the surface transportation which would otherwise be needed to connect smaller communities with distant air service.

While this net subsidy figure is based on an average of 3.8 flights a day, reducing the average service pattern to only two flights a day would still require an annual subsidy bill of more than $10 million, ALTA estimated. Eliminating all service from these smaller points would cause an estimated airline revenue loss of $5 million.

One of the major problems behind the increasing local service subsidy expense, the study noted, is that new cities added to the carriers' route systems have been drawn by CAB from a pool of communities which were formerly unserved. Most of the cities added in this manner were termed poor traffic producers unable to support a minimum service of two trips a day.

The ALTA study also cited CAB's proposed class mail rate plan as a practical means for the Board to monitor and predict subsidy costs while providing airline managements with incentives to reduce operating costs.

Maximum subsidy would be paid for the carrier's first round trip between any two cities under the proposed subsidy system, with subsidy per trip decreasing on a sliding scale basis as flight frequency increases. Average break-even need of individual airlines would be calculated on a costs and revenues standard for all carriers, rather than present system of setting this figure on basis of an individual study of each airline.

Aeronaves Is Seeking Replacement For DC-8 Destroyed at Idlewild

New York—Aeronaves de Mexico last week reportedly was seeking means to replace its single jet transport, lost Jan. 19 in a crash during takeoff from Idlewild in a snowstorm in near-minimum weather conditions.

The Douglas DC-8 in an apparent takeoff abort rammed a blast fence off the end of Runway 7, tore through a steel fence, struck a car on nearby Rockaway Blvd., and stopped in a marshy area after its nose section apparently broke off the fuselage and tucked under. Four Mexican crew members were killed but the other 102 persons aboard escaped before the plane burst in flames.

Civil Aeronautics Board last Wednesday interviewed Capt. William B. Poe, an Eastern Air Lines pilot who was riding in the jump seat in the DC-8's cockpit. He was thought to be a key witness in determining why the Mexico City-bound jet's takeoff was aborted. Poe was injured seriously in the crash but survived after apparently being thrown out of the opening formed when the cockpit section separated from the rest of the fuselage.

Investigators found braking marks on the runway, suggesting the aircraft may never have become airborne. About half the witnesses among the survivors reported that the plane was briefly airborne, while the other half said it was not.

After several days' search, the DC-8's flight recorder was found and is being examined in Washington.

Slush on the runway appeared to be ruled out as a possible cause of trouble, because the temperature was about 20F. A substantial part of the runway was relatively clear except for impacted snow.

Preliminary analysis of the engines indicated that the inboard units were developing full reverse thrust when the crash occurred.

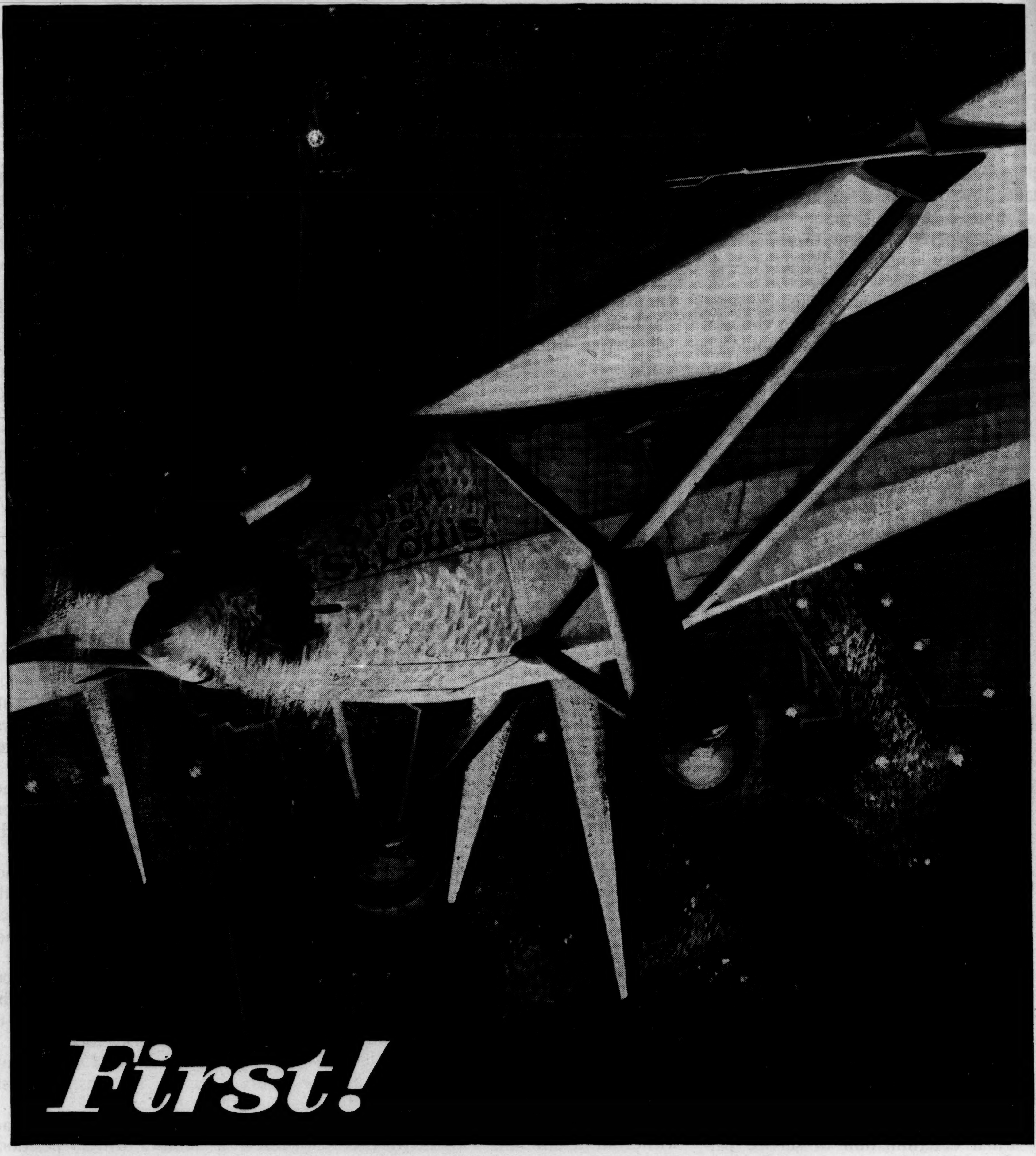
Aeronaves recently began jet service between New York and Mexico City simultaneously with Eastern Air Lines. The U. S. carrier had given up a place on the Douglas delivery line to make a jet available to Aeronaves so jet service, which had to be reciprocal, could be started. Aeronaves will take delivery of one turbofan DC-8 in October.

The DC-8 which crashed was to have been turned back to Douglas, and Eastern was to buy it.

Eastern last week said Aeronaves had not asked for another delivery position, and was not expected to. Eastern is relatively jet-poor at present and could ill afford to give up an early delivery.

Captain Poe was one of four senior pilots, qualified as check pilots, loaned to Aeronaves as observers and monitors during the Mexican carrier's initial jet operation. Another job of the Eastern pilots was to assist Aeronaves crews with air traffic control in the New York area.

Aeronaves now is flying the New York-Mexico City nonstop run with Bristol Britannia turboprop transports which provided the service before the introduction of jet schedules.



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Airline Income & Expenses—November, 1960

(IN DOLLARS)

	Passenger Revenue	U. S. Mail	Express	Freight	Charter	Total Operating Revenue	Total Operating Expenses	Net Income Before Taxes
DOMESTIC TRUNK								
American	28,734,997	630,459	377,000	2,069,076	....	32,217,809	33,818,161	−1,600,352
Braniff	5,437,642	161,734	61,931	184,385	111,475	6,053,719	5,983,479	−54,989
Capital	7,472,229	178,983	129,457	136,052	31,101	8,074,610	8,619,051	−544,441[4]
Continental	4,086,000	80,000	41,000	112,000	31,000	4,472,000	4,465,000	−283,000
Delta	10,250,000	199,000	126,000	301,000	36,000[6]	11,089,000	10,369,000	488,000
Eastern	18,921,296	464,875	1,006,555[5]	....	9,729	20,457,894	22,566,154	−2,409,456
National	4,134,349	95,892	22,070	189,535	241,410	4,820,716	5,939,852	−1,217,833
Northeast	2,794,614	46,825	24,151	69,613	....	2,981,142	3,480,733	−499,591[4]
Northwest	4,583,209	152,578	470,799[5]	....	153,751	5,496,688	6,546,374	−1,105,317
Trans World	17,706,119	466,129	1,279,773[5]	....	228,035	19,916,357	21,674,290	−2,082,249
United	25,481,041	1,129,976	2,218,964[5]	....	238,908	29,206,240	30,809,293	−1,846,670
Western	4,106,471	96,954	178,485[5]	....	53,002	4,459,568	4,475,461	−69,634
INTERNATIONAL								
American	440,551	8,852	362	68,253	....	539,800	728,732	−188,932
Braniff	699,742	25,818	....	45,376	....	826,688	985,678	−178,314
Caribbean Atlantic	246,546	2,724	13,428[5]	....	1,036	267,799	256,371	12,389
Delta	148,000	1,000	....	6,000	....	173,000	273,000	−106,000
Eastern	2,027,894	50,189	151,821[5]	....	....	2,231,104	2,674,982	−477,481
Mackey	122,369	....	618	2,702	....	135,062	153,144	18,082[4]
National	120,170	366	....	1,202	....	133,102	148,874	−15,772
Northwest	851,954	555,858	347,048[5]	....	3,080	1,864,568	1,988,347	−163,803
Pan American Combined	21,307,000	2,474,000	....	3,921,000	2,356,000	31,447,000	32,285,000	−1,672,000
Alaska	262,000	14,000	....	41,000	....	310,000	442,000	−131,000
Atlantic	9,359,000	1,124,000	....	1,503,000	131,000	12,792,000	14,489,000	−1,693,000
Latin America	4,928,000	201,000	....	1,206,000	275,000	7,299,000	8,919,000	−1,462,000
Pacific	6,758,000	1,135,000	....	1,171,000	1,900,000	11,406,000	8,425,000	2,656,000
Panagra	1,309,000	57,000	....	236,000	2,000	1,756,000	1,912,000	−157,000
Resort	....	....	....	....	8,456[2]	8,456	18,885	−3,512
Trans Caribbean	344,750	....	60,245[5]	....	4,800	432,652	531,782	−99,520
Trans World	3,443,939	713,102	708,496[5]	....	628,744	5,843,499	6,911,976	−1,244,261
United	1,323,662	62,235	43,170[5]	....	....	1,456,511	1,345,169	62,262
Western	486,906	7,307	17,134[5]	....	....	512,980	429,215	77,280
LOCAL SERVICE								
Allegheny	941,981	10,700	19,575	31,566	1,590[3]	1,292,200	1,572,591	−280,391[4]
Bonanza	374,853	3,242	3,216	5,094	4,388	667,463	665,735	−12,580
Central	190,303	6,500	2,584	7,392	7,414	472,199	451,715	20,483[4]
Frontier	508,181	14,818	4,348	25,533	6,487	1,079,473	1,075,389	−36,730
Lake Central	229,710	5,540	6,875	....	1,783	389,161	378,045	11,116[4]
Mohawk	897,696	13,801	13,708	16,568	27,948	1,175,850	1,278,761	−102,911[4]
North Central	893,399	28,511	20,000	26,734	8,689[3]	1,500,056	1,866,182	−381,573
Ozark	632,279	18,400	13,315	24,799	1,104[6]	926,254	973,175	−46,921[4]
Pacific	479,645	10,422	3,228	5,281	61,266	839,354	921,354	−116,929
Piedmont[8]	595,601	10,814	7,291	9,945	27,185[3]	1,007,743	996,507	−9,989
Southern[1]	....	....	....	....	....	....	....	....
Trans-Texas	401,595	23,596	5,586	18,006	19,673	699,844	682,454	62,839
West Coast	493,838	9,231	3,930	9,185	3,120	972,949	920,431	26,895
HAWAIIAN LINE								
Aloha[1]	....	....	....	....	....	....	....	....
Hawaiian	440,537	2,685	....	71,098	244,028[3]	761,697	836,057	74,360[4]
CARGO LINES								
AAXICO[2]	....	....	....	....	....	163,690	79,495	84,195
Aerovias Sud Americana[1]	....	....	....	....	....	....	....	....
Flying Tiger	....	7,890	939,743[5]	....	1,500,973	2,447,640	2,332,323	105,857
Biddle	....	....	....	657,536	....	664,615	789,329	−124,714[4]
Seaboard & Western	177,259	439,250	....	565,765	13,500	1,410,665	1,391,989	−135,463[9]
Slick	....	....	....	....	....	1,324,287	1,231,943	92,344[4]
HELICOPTER LINES								
Chicago Helicopter	131,607	131,514	....	....	....	263,423	307,991	−45,327
Los Angeles Airways	11,897	11,406	12,370[7]	....	1,129	127,186	115,784	10,405
New York Airways	85,303	3,540	3,253	3,906	....	296,568	311,858	−17,859
ALASKA LINES								
Alaska Airlines	193,564	54,961	603	50,183	284,280	759,410	724,772	31,991
Alaska Coastal	60,943	9,768	....	8,950	2,926	247,165	157,413	89,752[4]
Cordova	14,023	8,933	....	11,958	18,231	102,679	89,255	11,543
Ellis	40,300	4,400	5,100[5]	....	400	97,200	103,200	−6,000[4]
Northern Consolidated	57,837	52,301	....	26,283	2,116[3]	238,626	253,716	−15,089[4]
Pacific Northern	496,965	82,962	5,451	103,175	2,052	913,891	895,614	16,158
Reeve Aleutian	123,753	43,926	....	40,209[10]	9,905	222,444	208,218	16,226
Western Alaska[11]	60,053	16,220	....	8,953[10]	33,827	179,042	144,914	7,536[4]
Wien Alaska	49,262	62,264	....	24,192	27,681	334,357	350,779	−16,423[4]
Avalon Air Transport[1]	....	....	....	....	....	....	....	....

[1] Not available. [2] Other income—no operations this month. [3] Non-scheduled transportation. [4] Operating income or loss. [5] Property—express, freight, excess baggage. [6] Other transportation. [7] Express & excess baggage. [8] Airline division figures. [9] Net loss for period. [10] Freight & excess baggage. [11] Period 2/27/60 thru 11/30/60.

Compiled by Aviation Week from airline reports to the Civil Aeronautics Board.

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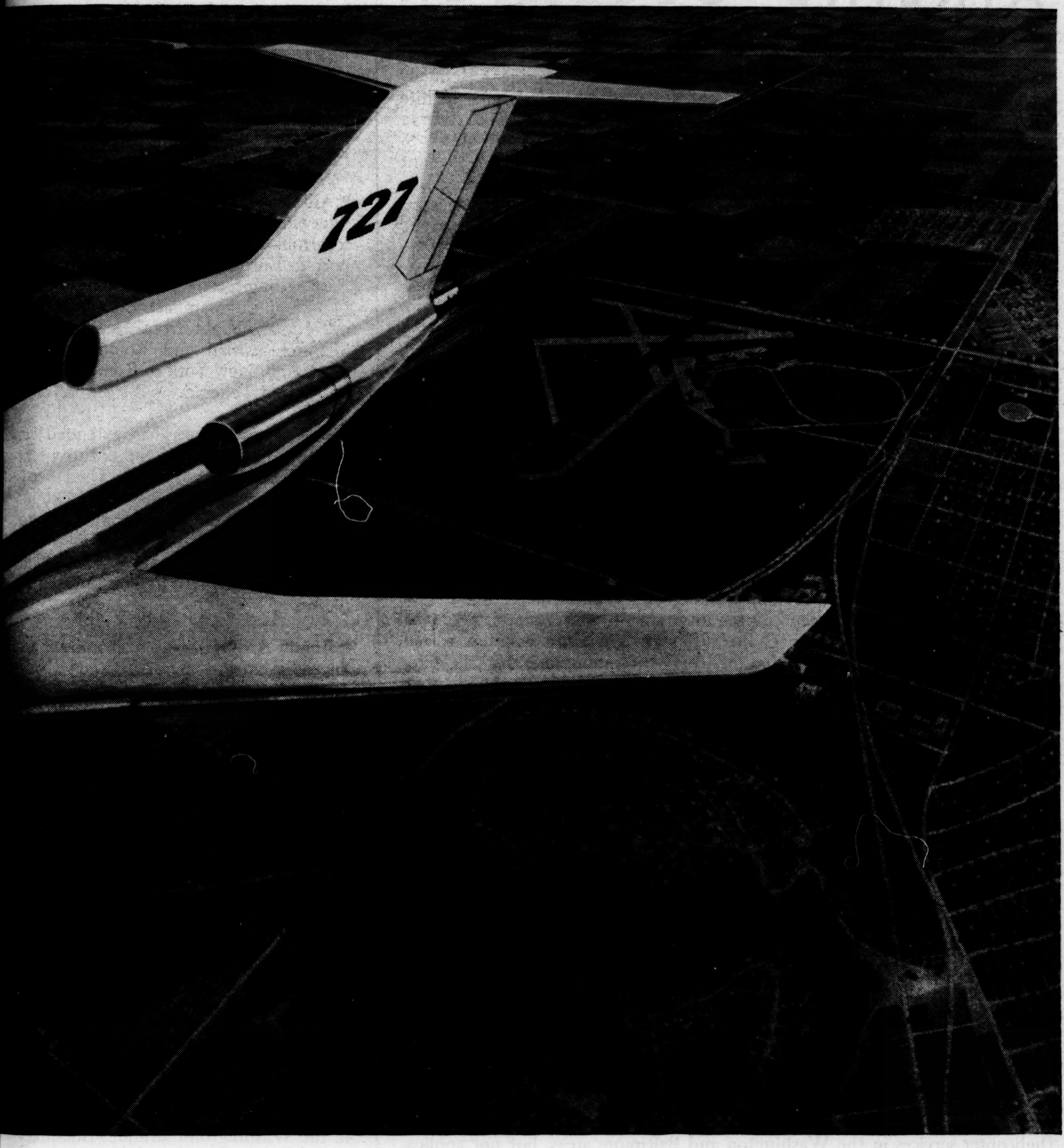
The three-engine 727 incorporates many of the structural and systems

's most experienced builder of jetliners



components proved in the 707 and 720. It also has the same cabin width, permitting 4-, 5- or 6-abreast seating to meet competitive requirements, whether for "big-jet" luxury or for high-density service.

The 727 is designed to operate from 5,000-foot runways with full payload, and to serve economically on routes from 150 to 1,700 miles. It offers the added profit potential of 850 cubic feet of cargo space. Speed is 550 to 600 mph.

Of equal importance, the 727 is backed by the outstanding performance, reliability and passenger appeal demonstrated in more than 223,000,000 miles of Boeing jetliner operations . . . good business reasons why *more* airlines have ordered *more* jetliners from Boeing than from any other manufacturer.

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AIRLINE OBSERVER

▶Najeeb Halaby, newly appointed Federal Aviation Agency administrator, has accepted the post with the understanding that he will have a free rein in running the organization and will report directly to President Kennedy as adviser on aviation matters. He may clash with James M. Landis, White House overseer of regulatory agencies, who feels FAA and CAB bear a close relationship to one another in the development of an over-all U. S. transportation policy. Landis is known to think that FAA is an independent agency in theory only. FAA will fight vigorously any attempts made to place it within the structure of an over-all transportation ogranization on grounds that it is not concerned with economic issues but confines its activities only to operational matters.

▶Growing battle between U. S. airlines and foreign flag carriers over the exchange of traffic figures (AW Oct. 17, p. 38) reached a climax last week when the Civil Aeronautics Board ordered an investigation to determine whether all foreign air carrier permits should be amended to require foreign airlines to submit traffic data and flight schedules for Board approval. In the past year, the U. S. has made a number of attempts to renegotiate bilateral air transport agreements to require a reciprocal exchange of airline traffic information but has consistently met with stiff resistance from foreign governments. Currently, only India exchanges traffic data with the U. S. Last year, Italy agreed to such a practice but later reversed its decision. Latest Board maneuver will intensify the controversy and could result in such retaliatory measures from foreign governments as capacity restrictions and tighter schedule controls.

▶Soviet Union has offered to supply India "any number of jet aircraft" of the latest type and will accept rupees in payment. The offer is receiving serious consideration in New Delhi, although a definite decision is not expected for another two or three months. Indications are that the offer covers both military and transport type aircraft. However, India's two state-owned airlines are known to be opposed to the use of currently available Russian-built transports.

▶Final Civil Aeronautics Board decision in the Capital-United merger case can be expected within the next 10 days. Oral arguments in the proceedings were completed last week. Decision probably will be announced with a press release, a practice the Board has not followed in recent months.

▶Government of Ghana has signed agreements to purchase two Boeing 707-420 transports and three Vickers VC-10 transports for use by Ghana Airways. Both aircraft types, which will be powered by Rolls-Royce Conway bypass engines, have been under consideration for some time by Ghana (AW Dec. 12, p. 38). The long-range fleet will be used on proposed routes to North and South America and will supplement the carrier's present medium- and short-range fleet consisting of six Russian-built Il-18 turboprop transports, two Bristol Britannias and three Vickers Viscounts.

▶CAB Bureau of Air Operations maintains that the forthcoming Helicopter Service Case should exclude fixed-wing aircraft service from the scope of the proceeding. Bureau advises the examiner to accept applications covering helicopter services in the Washington and Baltimore areas, but not applications for helicopter services between Washington and Baltimore.

▶International Air Transport Assn. traffic conference, now in session in Paris, has reached agreement on rates for the South Atlantic route between Europe and South America. New fares cut the price of a one-way jet trip between Paris and Rio de Janeiro from $540 to $410. Piston-engine economy fare on the route will be $380.

▶Aeroflot, which has been openly criticized for poor passenger service, is now accepting telephone orders for tickets in Moscow and is delivering tickets to passengers' homes. Tickets may be bought or ordered at a recently opened downtown ticket office in central Moscow.

SHORTLINES

▶**Airborne Freight Corp.**, an air freight forwarder, reports estimated 1960 gross revenues of $14.4 million, a 21% increase over 1959. Besides air freight, the forwarding firm handles travel services, customs brokerage and surface freight forwarding.

▶**Alitalia**, the Italian state airline, is now offering twice weekly all-cargo service from New York International Airport to Europe, Africa and the Middle East. Using recently converted Douglas DC-7F all-cargo aircraft, the carrier will operate one flight from New York to Shannon, Milan and Rome and the other from New York to Rome, Tripoli, Beirut and Teheran.

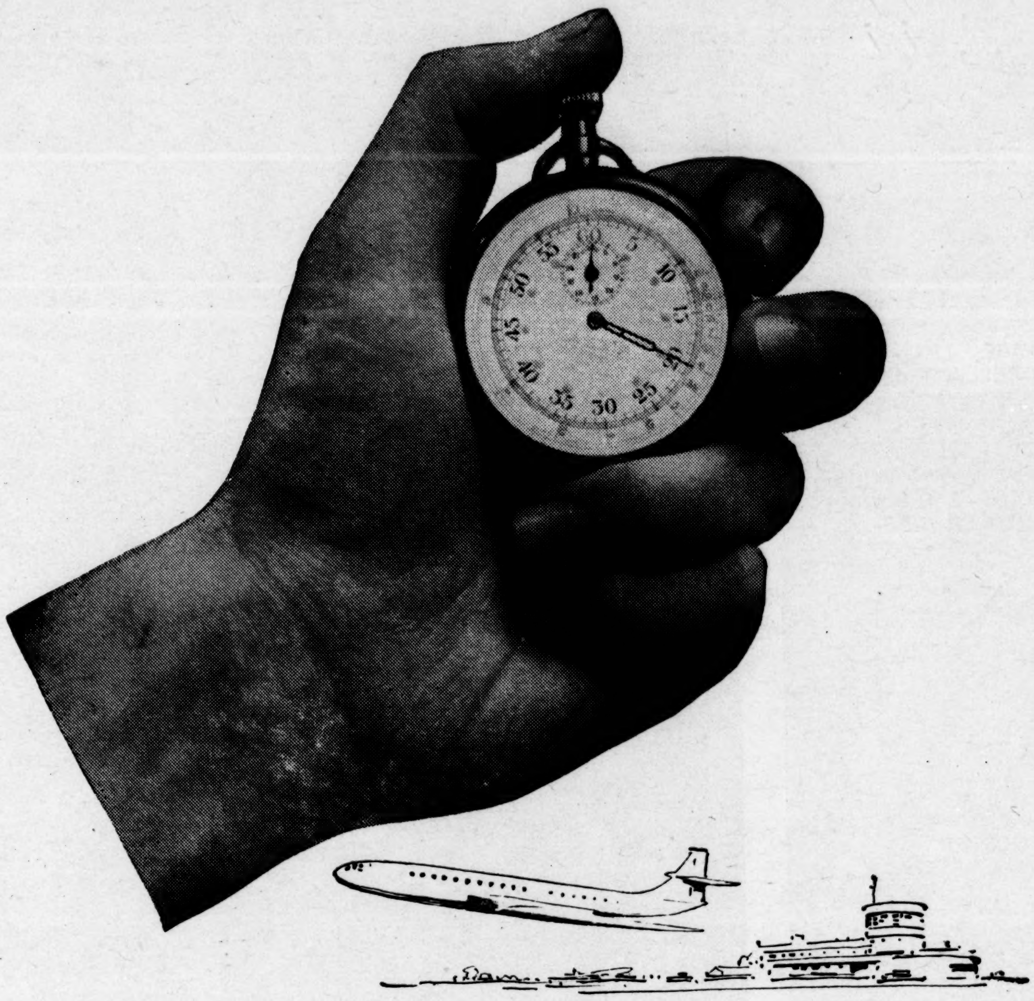
▶**Allegheny Airlines** has extended its family plan to include the entire week. Allegheny also has asked the Civil Aeronautics Board for permission to extend its group travel plan, applicable to groups of 10 or more traveling round trip, to all points on its system. Plan now applies only to a limited number of routes.

▶**Braniff Airways** plans to introduce reduced excursion fares between New York, Miami and Houston in the U. S., and Rio de Janeiro, Sao Paulo, Montevideo and Buenos Aires, Feb. 12, subject to the approval of the governments concerned. New excursion fares would offer savings up to $100 and would be effective for 90 days instead of the present 45 days.

▶**Chicago Helicopter Airways** reports it carried 309,107 passengers during 1960, a 51% increase over 1959. The helicopter line flew 5,204,292 revenue passenger miles, compared with 3,667,366 flown in 1959.

▶**National Airlines** has received Civil Aeronautics Board permission to continue operation of three-stop service between Baltimore and Tampa/St. Petersburg until Feb. 1. The Board's decision in the Washington-Baltimore Adequacy of Service Investigation said National must operate the flights with two intermediate stops. The carrier says most of its business is between Washington, Jacksonville and Orlando, making the three stops necessary, but an attempt will be made to implement the Board's order.

▶**Pan American World Airways** has resumed nonstop service between Miami and Kingston, Jamaica, after a lapse of several years. The carrier has been flying into Kingston via intermediate stops.



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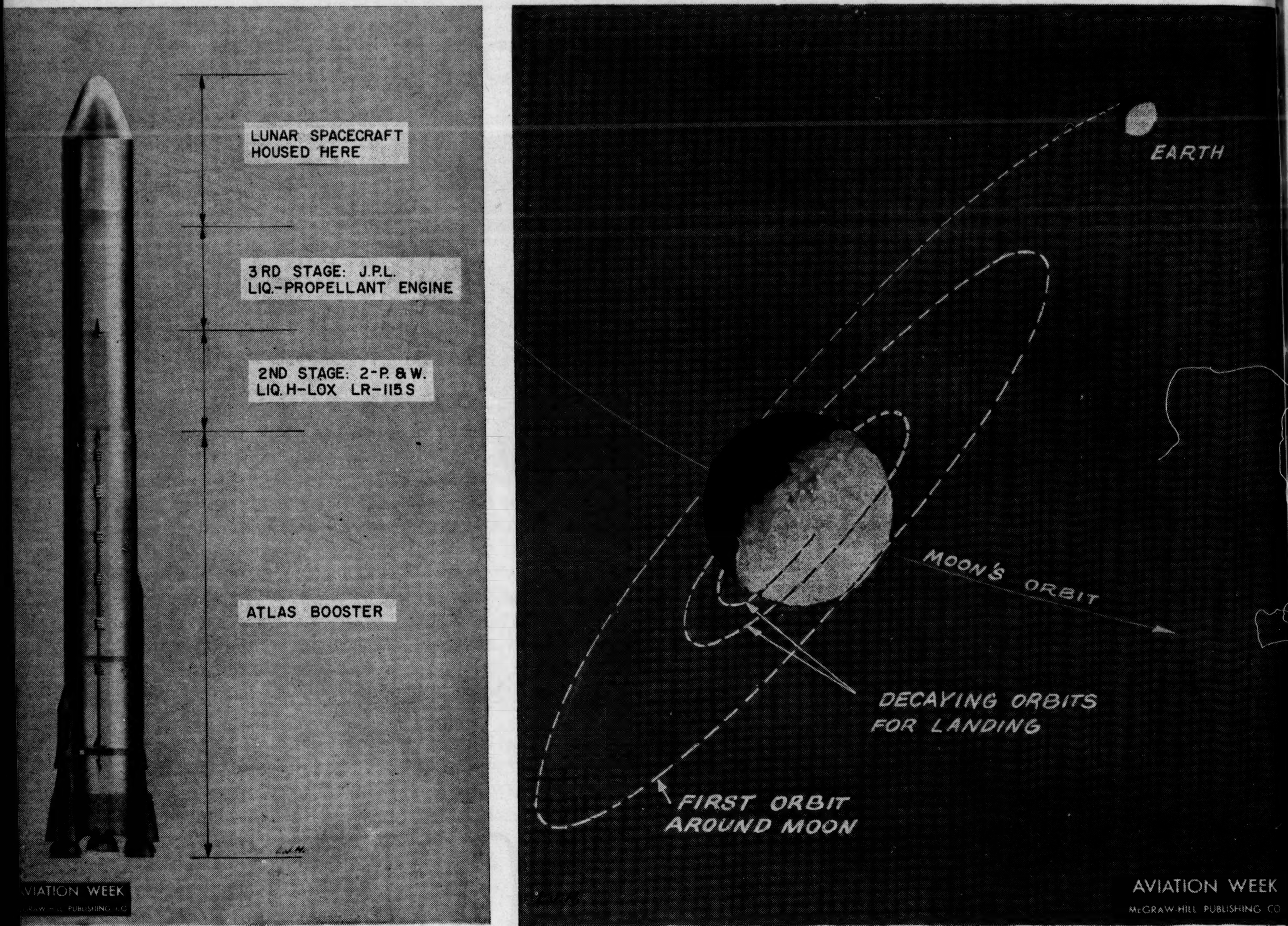
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THREE-STAGE Centaur vehicle (left) will inject lunar soft-landing spacecraft into trajectory to the moon. Spacecraft's injected weight will be 2,500 lb. and vehicle will have to fit within a payload fairing having a 9-ft.-diameter limit. Orbital scheme depicted at right would allow a few, or many, payload passes. Retrorockets cause the orbit to decay for touchdown at selected site.

Surveyor Lunar Spacecraft Has Varied

By Irving Stone

Los Angeles—Seven spacecraft, each carrying equipment for drilling the lunar crust, plus about 250 lb. of instrumentation for environmental measurements, are programed to be soft-landed on the moon at regular intervals during 1963-1966 under Project Surveyor, sponsored by the National Aeronautics and Space Administration's California Institute of Technology Jet Propulsion Laboratory.

Requirement will be to penetrate the lunar subsurface to a depth of about 18 in. to 5 ft. for extracting material samples for analysis.

Telemetry from the soft-landed Surveyor spacecraft is expected to relay data for at least one month, possibly for as long as three months, if the hazards of landing and temperature extremes are overcome.

Total weight of the spacecraft entering the lunar vicinity will be approximately 2,500 lb., with about two-thirds of this weight allocated to the vehicle's propulsion system, which will supply midcourse correction, and retro-thrust and vernier thrust for zero-speed touchdown. Total weight of the soft-landed package may be about 750 lb. including drilling equipment, instrumentation, power supplies and environmental equipment, and structure.

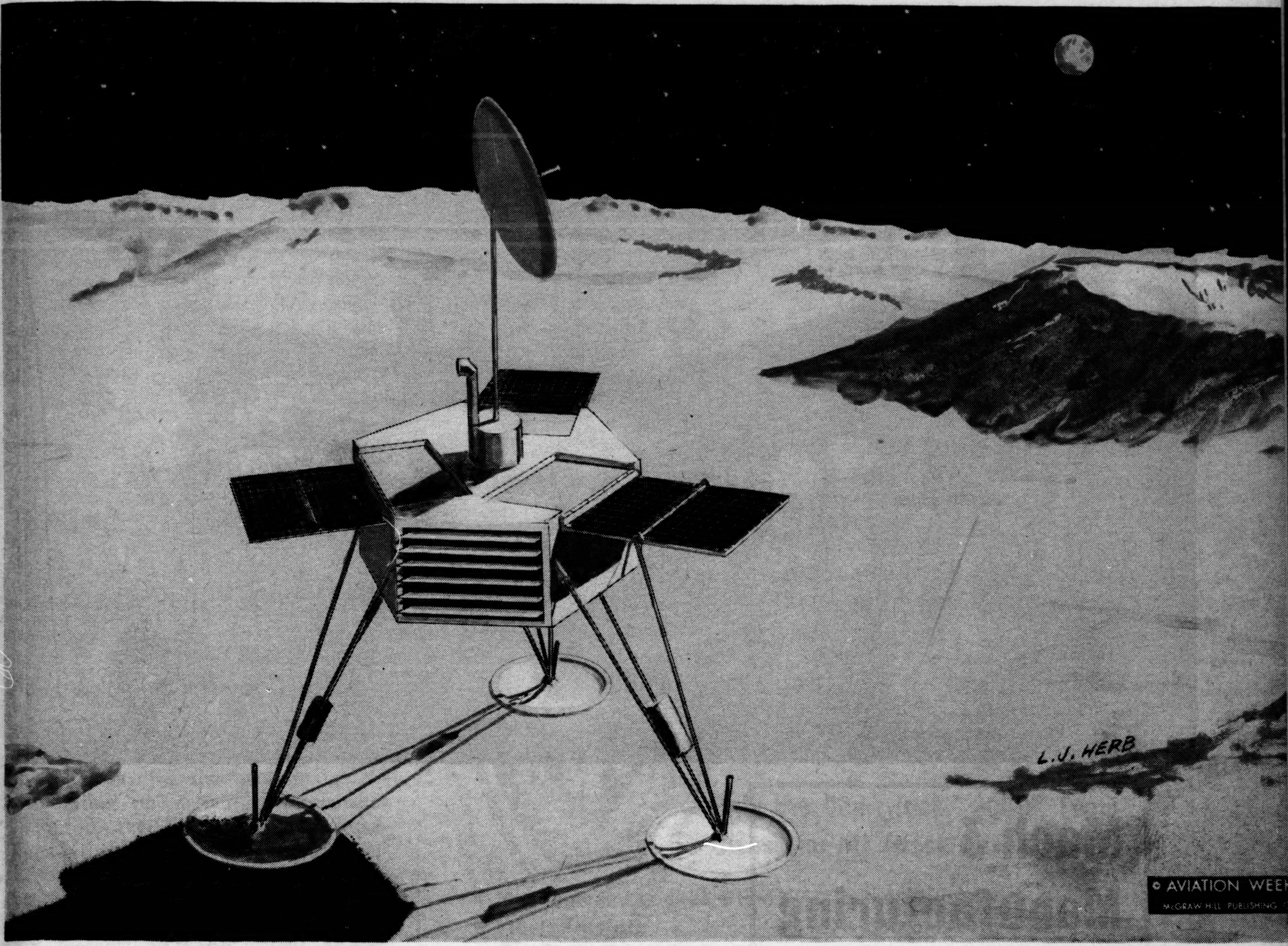
Hughes Wins Contract

Hughes Aircraft Co. will design and build a soft-landing lunar spacecraft for NASA's California Institute of Technology Jet Propulsion Laboratory. Hughes was selected from four industry competitors, including McDonnell Aircraft Corp., North American Aviation and Space Technology Laboratories.

In a program costing more than $50 million, seven tripod-type spacecraft will be launched. Doppler radar-radio altimeter technique probably will be used to control letdown (see story).

Surveyor spacecraft will have to be completely contained within a 9-ft.-diameter fairing on top of the three-stage Atlas Centaur boost vehicle, which will have the Air Force Ballistic Missile Division's Convair Atlas 380,000-lb.-thrust ICBM for first stage, a pair of Pratt & Whitney LR-115 liquid hydrogen-liquid oxygen engines with total thrust of 30,000-40,000 lb. for second stage, and a JPL 6,000-lb.-thrust storable-liquid propellant engine for the third stage. It will be launched from Cape Canaveral, Fla., to put the spacecraft into its transfer trajectory to the moon (AW Dec. 19, p. 23).

Surveyor, by reason of the pioneering nature of the experiment, necessarily will be confined to a relatively limited lunar area for extraction of scientific data, but nevertheless will form the basis for similar and some follow-on experiments contemplated with Project



ARTIST'S version of lunar soft-landed spacecraft has tripod-like landing gear fitted with dish-shaped pad on bottom of each leg. Solar panels would fold into the body to protect against extreme cold during lunar night; shutters would open to radiate payload heat during lunar days. The periscope at center would rotate to scan the lunar surface for television cameras installed inside.

d Approaches

Prospector, involving the advantages of a mobile landing package for covering a much broader lunar area. Similarly, Project Ranger (AW June 20, p. 203), which will precede Project Surveyor, should produce valuable scientific inputs for Surveyor to ease some of the natural hazards expected to be encountered in the lunar soft-landing.

Safe Letdown

Lunar surface and subsurface unknowns will impose the critical condition of designing for a broad range of hazards to ensure safe letdown and post-landing operation of the instrument package.

Depth of the surface dust layer, its degree of concentration with depth, surface inconsistencies due to cratering by meteorites and other space phenomena, will have a profound effect on the choice of landing gear for the lunar soft package, on terminal guidance sensors using radar, and on other important aspects related to the landing package.

If the letdown pattern is direct—normal or slant approach to the lunar surface—various landing gear configurations probably could be used for compatibility with estimations of surface makeup:

- **Tripod landing gear,** most popular in the numerous pictorial representations of lunar landing operations, probably is favored by the competing designs and is a feasible configuration having specific advantages and disadvantages.

It is relatively simple and straightforward design, and is a stable structure if any one leg is not deformed to the extent that it might promote overturning.

Legs would require an effective compression system incorporating the characteristic of high energy absorption and relatively little elasticity. Crushable-material struts, rather than fluid-damping, would seem to be indicated in this case.

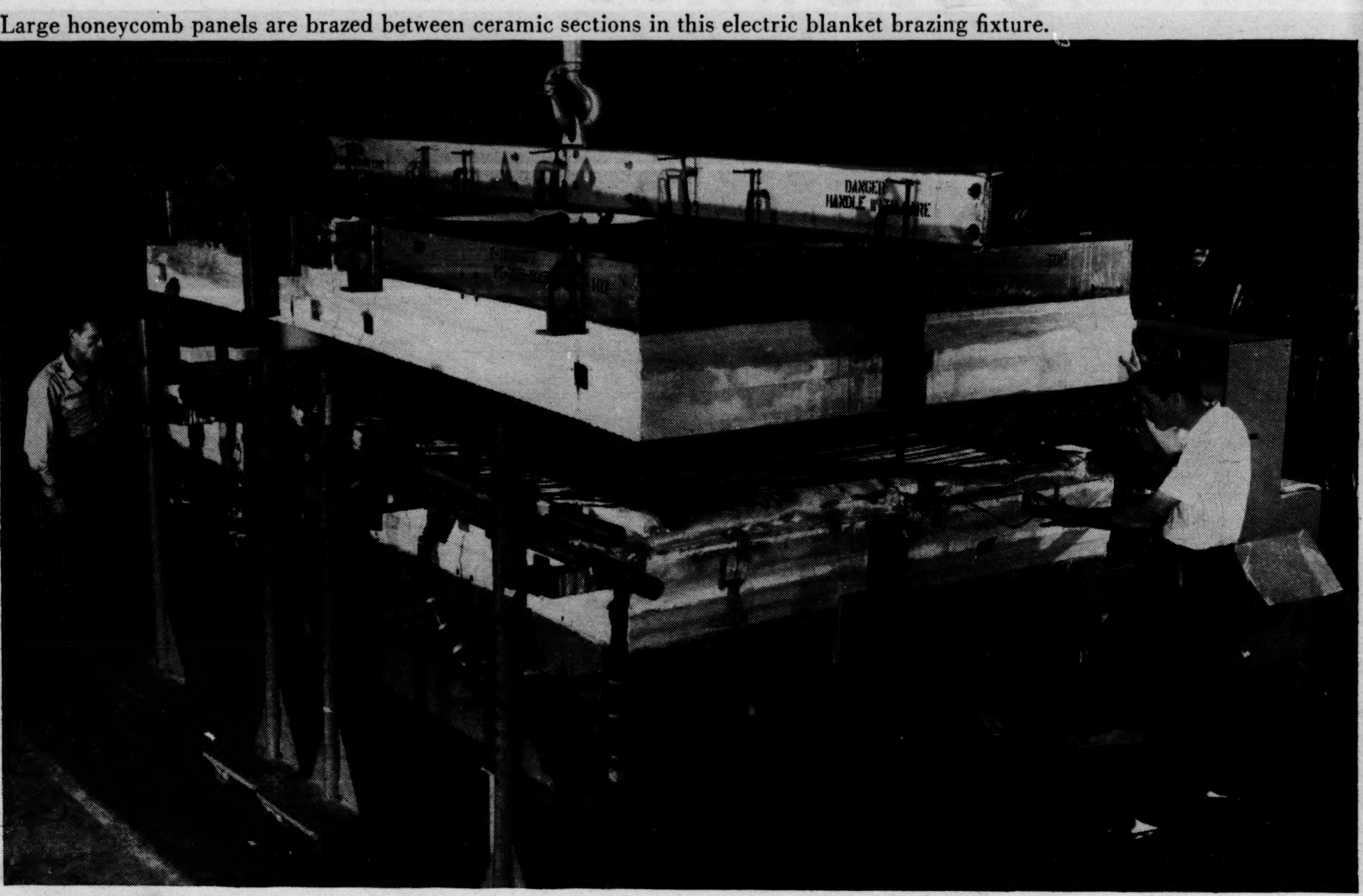
Each leg would have to carry large-footprint pads to minimize danger of sinking, to any extent, in soft dust or in a relatively hard but brittle porous crust.

Attitude control for the tripod-type landing gear would have to be relatively precise to avoid overturning at touchdown. Also, the over-all weight of the structure—legs, brace members, energy-absorbing struts, and large, energy-absorbing footpads—might be substantial and approach the critical limitation set for the landing package support system.

Hollow drills or punches for obtaining subsurface samples conceivably could be fitted to the footprint pads, to be actuated with contact with the lunar surface.

- **Random landing** of a lunar soft-package would be feasible to avoid the control problems inherent in achieving letdown with precise attitude to ensure proper orientation of some instrumentation, communication antennas and drilling equipment. For the random-attitude landing, the package could be an egg-shaped configuration

Large honeycomb panels are brazed between ceramic sections in this electric blanket brazing fixture.



Mach 3 Manufacturing

Making an aircraft skin tough enough to withstand the heat barrier To cope with the heat barrier and cruise at speeds in excess of 2000 miles an hour, an aircraft needs a skin unlike that of any plane in existence. Traditional covering methods were out of the question.

To solve this problem, the engineers and scientists at the Los Angeles Division of North American Aviation carried on further experiments with the techniques of manufacturing stainless steel honeycomb. They found that by sandwiching this honeycomb between two sheets of steel, sometimes only six thousandths of an inch thick, structural sections could be obtained with excellent insulating characteristics and stiffness approaching a solid slab of steel, yet would be far lighter.

The problem of brazing these honeycomb panels to meet the oven-hot temperatures of Mach 3 speed required an intensive development program. In conjunction with NAA's team of subcontractors, experiments were made with many kinds of brazing methods. One in particular would give high-quality results, with economy. This method utilizes a ceramic form to hold a honeycomb panel at controlled heats of over 1625 degrees.

As a result of this advanced development in the art of making aircraft coverings, a plane can now have a skin so tough it is well able to withstand thermantic speeds.

This technological breakthrough will help sustain America's leadership in aircraft and make possible the supersonic manned weapon systems and commercial aircraft of the future. Because of metallurgical achievements in supersonic fabrication, the American Society of Metals gave North American its 1959 Advancement of Research Award.

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with center of gravity disposed so that the package would come to an upright position regardless of the attitude at touchdown. This, however, would involve ballast problems, thus adding to the weight of the package. Another scheme might be to land the egg-shaped package at random, then cause its erection into the proper attitude by extending the rigid sides mechanically as if they were being "peeled" from the body, using one end as a pivot point. The peeled sides would erect the package into proper position, giving it stability with broad, firm footprints on the lunar surface.

Minimize Bounce

The sides of the package could be composed of impact-absorbing material having a low degree of elasticity to minimize bounce at touchdown and to protect against hazard of tumbling if there were a horizontal velocity vector. The sides also could incorporate the material insulation required to protect the instrumentation and equipment from the −153C temperature of the long lunar night (14-day duration) by folding the sides back into the original closed position.

Simple as this scheme might seem, it would involve the necessity of incorporating an actuating mechanism to perform the "peeling," thereby introducing the possibility of malfunction inherent in any mechanism. Additional weight would be involved because of the greater quantity of impact-absorbing material and the weight of the actuating mechanism, which could be energized by gas stored under pressure as one of the simplest methods.

- **Inflatable ring,** similar to the automobile inner tube but with higher ratio of ring material to middle opening, is another feasible lunar landing gear device. It is a simple approach to the problem, need not involve any actuating mechanism. Inflation would be achieved with pressurized gas directed through valving.

Folded Bay

Uninflated, the bag could be folded and easily stored within a relatively small volume for deployment by inflation before the touchdown phase.

The ring could be divided by flexible bulkheads made of the same material as the bag, affording a multiplicity of compartments which would afford a built-in factor of safety in the event any one compartment were punctured or ruptured at touchdown.

The inflated ring would constitute its own broad footprint, probably best for soft dust or brittle porous surface which may be encountered. Stability also would be afforded by the configuration, with little danger of overturning.

The ring would serve as its own dis-

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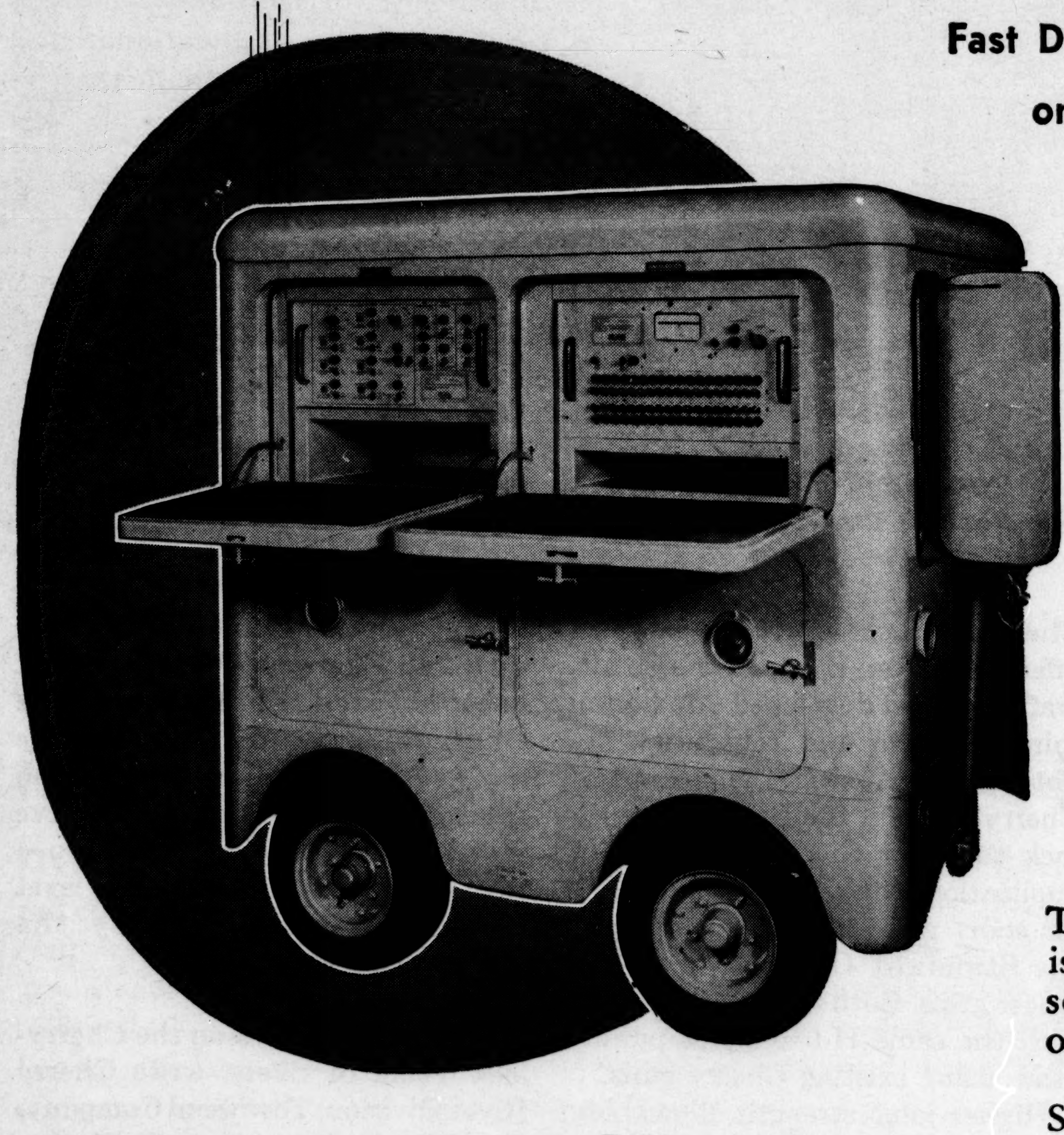

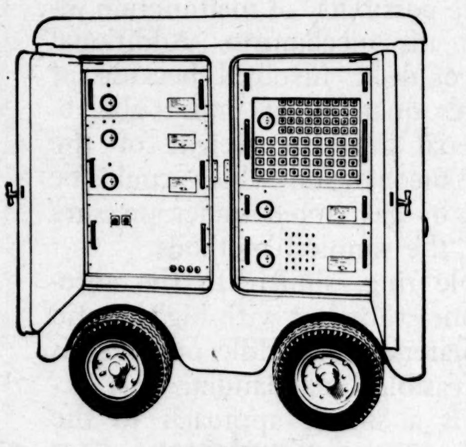

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sipating medium for the landing-force with the internal gas absorbing the shock, and safety valves opening to dissipate the kinetic energy to minimize bounce.

The ring-shaped bag also could adapt itself to an uneven terrain or one with sloping contour.

- **A spike-type landing gear** probably seems the most attractive from the viewpoint of simplicity and the possibility exists of using a hollow spike as a punch for penetration instead of a hollow drill to penetrate the lunar surface for sampling subsurface material and also for obtaining a subsurface temperature profile.

Degree of penetration with the spike would be critically dependent on touchdown velocity. Too high a velocity might bury the spike and the package above it too deeply if the surface was powdery. If the surface was relatively hard, an unreasonable amount of force for penetrating might be required and the resulting shock of touchdown might be too great for the instrumentation to withstand.

A configuration involving a multiplicity of spikes conceivably might be used to promote proper orientation of the landing package, to prevent overturning or tumbling, which might be encountered in the case of the single spike configuration.

Because of its self-penetrating characteristics, the spike-type landing gear by acting as a punch conceivably could eliminate what might be a problem with a rotating drill. The latter, by reason of its rotary motion, would impart a corresponding turning force to the landing package itself unless it were sufficiently heavy, or anchored to the lunar surface to prevent its rotation.

Terminal Guidance

Another problem equal to, or exceeding, that of landing gear design for the lunar soft-landing will be the effectiveness of the terminal guidance system. The softer the landing, the more likely the landing package will be sustained by the lunar surface and in a favorable attitude to perform experiments and communicate with the earth. Ideally, the landing package should have zero-velocity at the instant of touchdown, but optimistic projections vary from 10 to 30 fps. Another complication exists in the balance that must be maintained between vertical and horizontal components of velocity, to prevent overturning or tumbling at touchdown.

Lunar surface reflectivity also will have an effect on the efficiency of terminal guidance sensors if radar is employed, but previous experiments which bounced radio signals off the moon, together with associated analyses, indicate that radar sensing with the lunar surface probably will be practical.

Project Surveyor Typical Experiments

Surface Chemical Analysis

1. X-ray fluorescence spectrometer.
2. Neutron activation techniques.
3. Mass spectrometer.
4. Gas chromatography (detection of organic molecules).

Surface Physical Analysis

1. Densitometer (gama-ray scattering).
2. Thermal and electrical conductivity measurements.
3. Sound speed measurements.
4. Vidicon, with variety of magnifications.

Local Subsurface Properties

1. X-ray spectrometer and neutron activation instrument in hole.
2. Vertical temperature gradient measurement.
3. Thermal and electrical conductivity measurements.
4. Densitometer.

Structure

1. Three-axis seismometer.
2. Gravimeter.

Critically tied to the success of the terminal guidance operation is the spacecraft propulsion system for supplying letdown retrothrust and vernier thrust for fine control in the ultimate landing regime.

Several terminal guidance schemes appear feasible:

- **Radio-beacon homing.** This method would involve the use of a pair of radio beacons expelled at successive times in the descent of the spacecraft towards the moon. First beacon would not survive impact, but the second would survive to provide final guidance for a soft touchdown.

After the spacecraft is properly targeted towards the moon by spacecraft propulsion vernier thrust in a final midcourse trajectory correction, a radio beacon is expelled for impacting on the moon where the spacecraft normally would impact in continued unpowered flight.

The speed of beacon expulsion from the spacecraft causes the latter to lag the beacon so that when the beacon impacts on the moon the spacecraft is perhaps 100 to 200 mi. from the lunar surface.

Tracking, from the spacecraft, of the beacon to its point of impact results in data which pinpoints the spacecraft's position and its velocity direction.

At a relatively short distance above the lunar surface the second beacon, designed to survive impact and prevent burial in the lunar surface, is ejected, is tracked by the spacecraft and guides it to a soft landing. Retrothrust and vernier thrust of the spacecraft's propulsion system reduces the vehicle's vertical speed to zero or at least to the speed tolerance required for safe touchdown.

- **Optical homing on lunar marker.** An optical marker on the lunar surface could be either a dye or some other means of identification, previously landed on the moon, a condition which would add considerably to the cost of the soft landing experiment.

It probably would not be feasible to use some natural surface feature of the moon for tracking optically from the spacecraft because good resolution of an area equivalent to that required for landing probably could not be obtained, and the numerous lunar features in a particular area apparently would be so similar that confusion would be introduced for tracking system discernment.

Used in conjunction with the optical tracker is a radio altimeter for accurate retrothrust control for the required soft touchdown.

- **Vidicon.** Coupled with command control from an earth station, a television camera in conjunction with a radar altimeter in the spacecraft could be used for the soft landing regime by choice of a specific landing point, with the camera pinpointed to eliminate the lateral velocity vector and the altimeter functioning with retrothrust of the spacecraft's propulsion system to minimize vertical velocity.
- **Optical tracker.** This is similar to the TV camera system, but uses a telephoto camera to eliminate the lateral velocity component, and a radar altimeter in conjunction with retrothrust to eliminate the vertical component for a safe touchdown. In this system, optical observation is processed in the landing package instead of an earth station.
- **Doppler radar.** This system, in conjunction with a radar altimeter, will depend for its success on the lunar surface's electromagnetic scattering characteristics. The system measures the lateral and vertical velocity components beginning at an altitude probably in the region of two to three miles, with retrothrust and vernier thrust being used successively to achieve a soft touchdown of minimum velocity.

Propulsion System

Selection of propulsion system for the spacecraft is a critical consideration for both terminal guidance and landing regimes. Liquid and solid propellant systems are suitable for use, as well as liquid hydrogen-liquid oxygen system with its inherent high specific impulse, but which may be unsuitable because of the difficult storage problems associated with the propellant.

A solid-propellant rocket engine for

the spacecraft's main engine would be desirable because of simplicity, but several difficulties would be introduced in providing for multiple-start capability, altering direction of thrust, and operation at very low temperature. The solid rocket probably would have to be complemented by a liquid vernier engine for spacecraft's midcourse correction and final retrothrust at lunar letdown.

Hughest Aircraft is incorporating the use of a solid propellant main retrorocket, coupled with the use of a final-letdown vernier engine.

Use of a monopropellant for midcourse correction and vernier retrothrust at final letdown is a promising possibility because of prior experience with this application, as well as its demonstrated restart capability. For main retrothrust of the spacecraft, the monopropellant could be combined with another propellant for hypergolic reaction of higher specific impulse.

Probability is not great that a combustion system would be used for auxiliary power and for a source of heat during the extreme cold of the lunar night, but if it was, the hypergolic liquid fuel combination would be feasible.

Mechanical Complexity

Both single or two-stage propulsion systems are feasible for the spacecraft. Jettisoning the first stage would involve mechanical complexity, would lighten the space package for landing, but also might crater the lunar spot where the payload might land and stir up such a quantity of dust that the guidance sensing may fail to penetrate it.

Retrorocket exhaust from the landing package also may crater the lunar surface to tilt or overturn the payload, and may introduce chemical contamination interfering with instrument readings. As in the case of jettisoning the first stage, final retrothrust exhaust also may stir up sufficient dust to cover the solar panels, if these are used, and drastically cut down on their efficiency, possibly render them useless.

Orbital Approach

Selection of a specific site for landing may require an orbital approach to the lunar surface instead of the direct letdown for landing on the moon. If an orbital path is specified, it will have an effect on the type of guidance, propulsion, and landing gear systems selected.

The orbital approach, probably more difficult than the direct descent, offers many advantages. Orbiting the moon for a few passes or for an extended period, depending on degree of data desired, the spacecraft could relay television pictures of a substantial portion of the lunar surface back to an earth ground-command station which, by command, could program a decaying orbit, then a final orbit for touchdown at a specific site.

With an extended orbital period—perhaps a number of weeks—a large number of lunar-environment experiments could be performed and substantial topographical data obtained prior to initiating the hazardous lunar landing. Pictures obtained from the Ranger experiments could help substantially in prior selection of landing sites.

Guidance equipment also could be tested during the orbital phase and information telemeterd to earth. If a malfunction was spotted, it would be possible to switch to a duplicate backup system if this was carried aboard the spacecraft as a critical precaution.

Less thrust would be required in an orbital approach than for a direct approach using a near-perpendicular letdown as distinguished from a direct approach using a near-horizontal approach path.

Possibility of blotting out an optical sensor by the engine exhaust trail also would be considerably less in the orbital approach than it would be in a direct, near-perpendicular approach.

Need for thrust control also might be eliminated with the orbital approach whereas in a direct, near-perpendicular letdown, throttling of the retrorocket may be required, or the use of fast or slow on-off periods or a constant-thrust vernier.

Despite the hazards of vacuum, radiation and micrometeorites, temperature control of the landed package probably will be the most critical environmental hurdle. Complete insulation of the package surely will be required during the long lunar night.

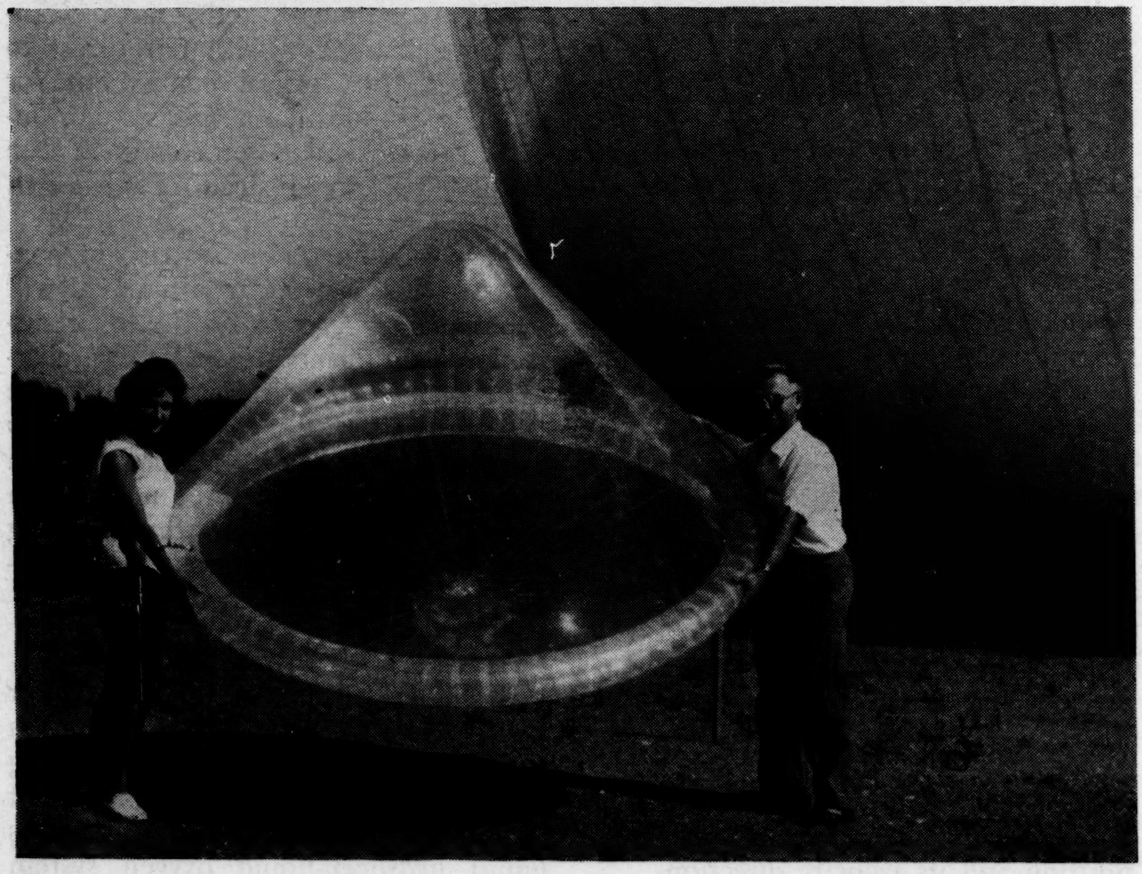
Heat Leakage

To make up for heat leakage from the package during the night it probably will be necessary to use the heat from equipment or provide a separate heat source for that function. During the lunar noon, some method of dissipating the package heat will have to be employed. Similarly, any power supply system which uses a combustion process will have to have the hot exhaust products bled off during the lunar day.

Probability is that solar panels will be used as a power source for the lunar package but the extreme cold of the lunar night will impose the necessity for protecting the cells, possibly by retracting the panels within the payload insulation or providing some means for sheathing the arrays of cells.

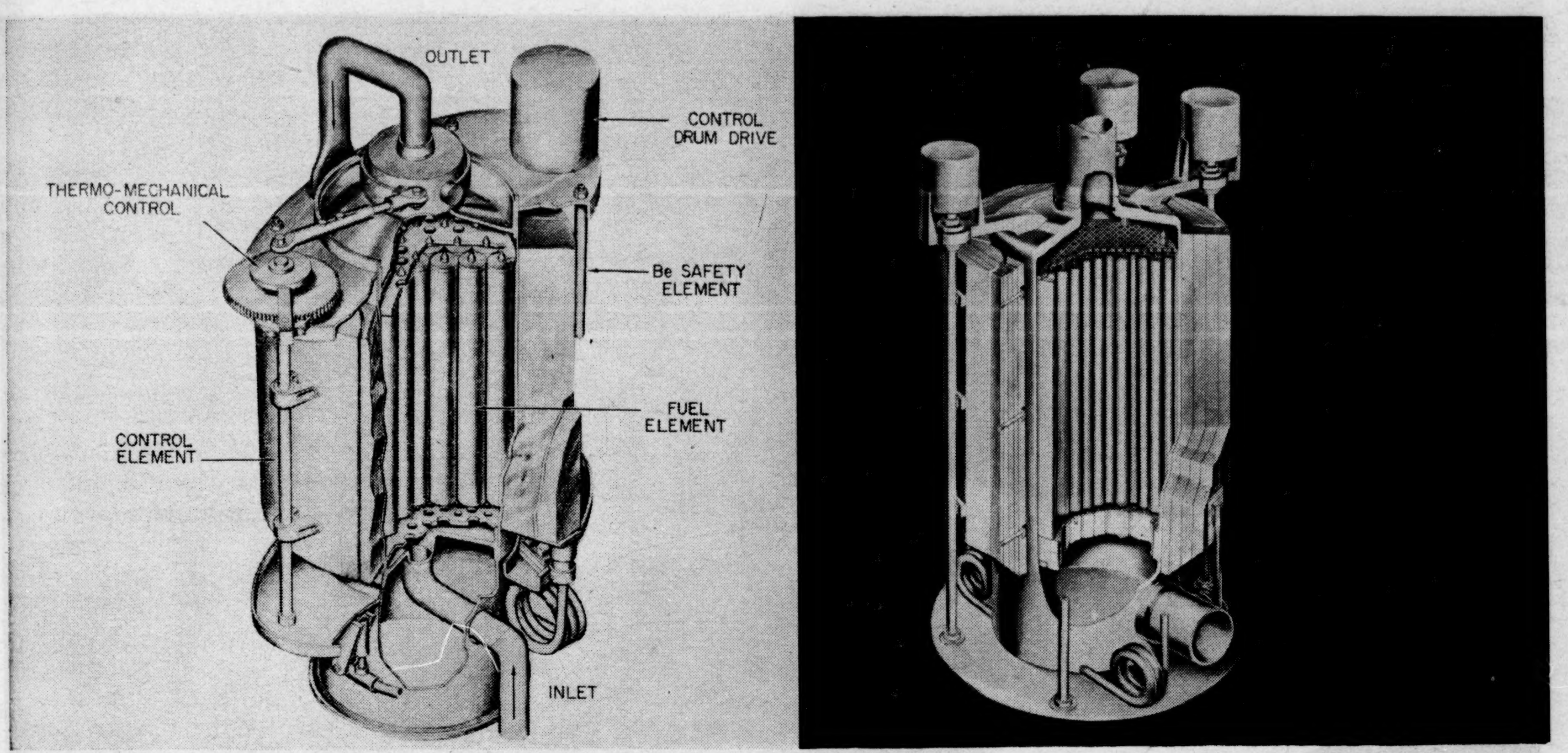
Non-regenerative fuel cells also are being considered as a primary power source.

Estimates of power requirements for the Surveyor experiments vary. Indications are that as much as 175 to 200 watts may be required for the full load of experiments but, to conserve power, it is not likely that all experiments will be conducted simultaneously. An average power requirement for the first lunar day may be approximately 50 watts, then drop off for successive data-gathering periods.



Inflatable Solar Collector Developed

Solar collector designed for space applications can be packed into a canister about the size of a coffee cup, according to the developer, G. T. Schjeldahl Co., Northfield, Minn. Parabolic Mylar reflector is 7 ft. in diameter and is undergoing static tests.



FIRST LOW-VOLUME reactor for use in space power systems will be the Snap 2 reactor (left). The prototype Snap 2 reactor is now running. The operational reactor will have a core volume of about 0.3 cu. ft., will produce 50,000 thermal watts and weigh only 200 lb. Snap 8 reactor (right) which entered development phase in January, 1959, is in many respects a scaled-up version of the Snap 2. The Snap 8 can run one or two turbogenerator sets and therefore can produce either 30 or 60 kw. of electrical power. National Aeronautics and Space Administration has contracted development of conversion machinery for use with Snap 8 in Agena and Centaur space vehicles.

Snap 1-A Targeted for 1961 Operation

This is the sixth and final article of a series on various applications of nuclear power to aircraft, missiles and space vehicles.

Washington—Development of systems for nuclear auxiliary power (Snap) has progressed more rapidly and satisfactorily than any other U. S. nuclear power program for space and flight.

The first relatively low power Snap system for space vehicles, Snap 1-A delivering 125 watts for one year, will be ready for operational service in off-the-shelf form in 1961. The program did not formally begin until 1955, and detailed system design did not start until 1956. Higher power systems, such as Snap 8, producing up to 60,000 watts, are scheduled for flight testing in 1966 or 1967.

The general Snap concept dates from 1946. It evolved from Air Force-sponsored studies of reconnaissance satellites by the Rand Corp. from 1946 to 1954, which showed that the long-life power sources needed by satellite instrumentation and equipment could only be supplied by nuclear systems.

Implementation of the recommendations of these satellite studies began in 1955, and a weapon system, WS-117L, had evolved by 1956. It was called the Air Force Advanced Reconnaissance System. Midas, Discoverer and Samos projects all stem from WS-117L. Vehicles developed by these projects will make extensive use of Snap power units which began development at the same time as WS-117L.

The complete Snap program includes small nuclear power units for use on shipboard and in isolated areas as well as for space vehicles. Development of the nuclear components for all the Snap systems is the responsibility of the Atomic Energy Commission, and this work is managed for the commission by its Aircraft Nuclear Propulsion Office, headed by Brig. Gen. Irving L. Branch.

Two nuclear heat sources were shown by preliminary studies to be the most attractive for small Snap-type units and to have the most growth potential. They are radio-isotope decay and nuclear fission. Radioisotope units are generally limited to a power level of 1 kw. and less, while fission reactor systems are practical from 3 kw. to thousands of kilowatts output.

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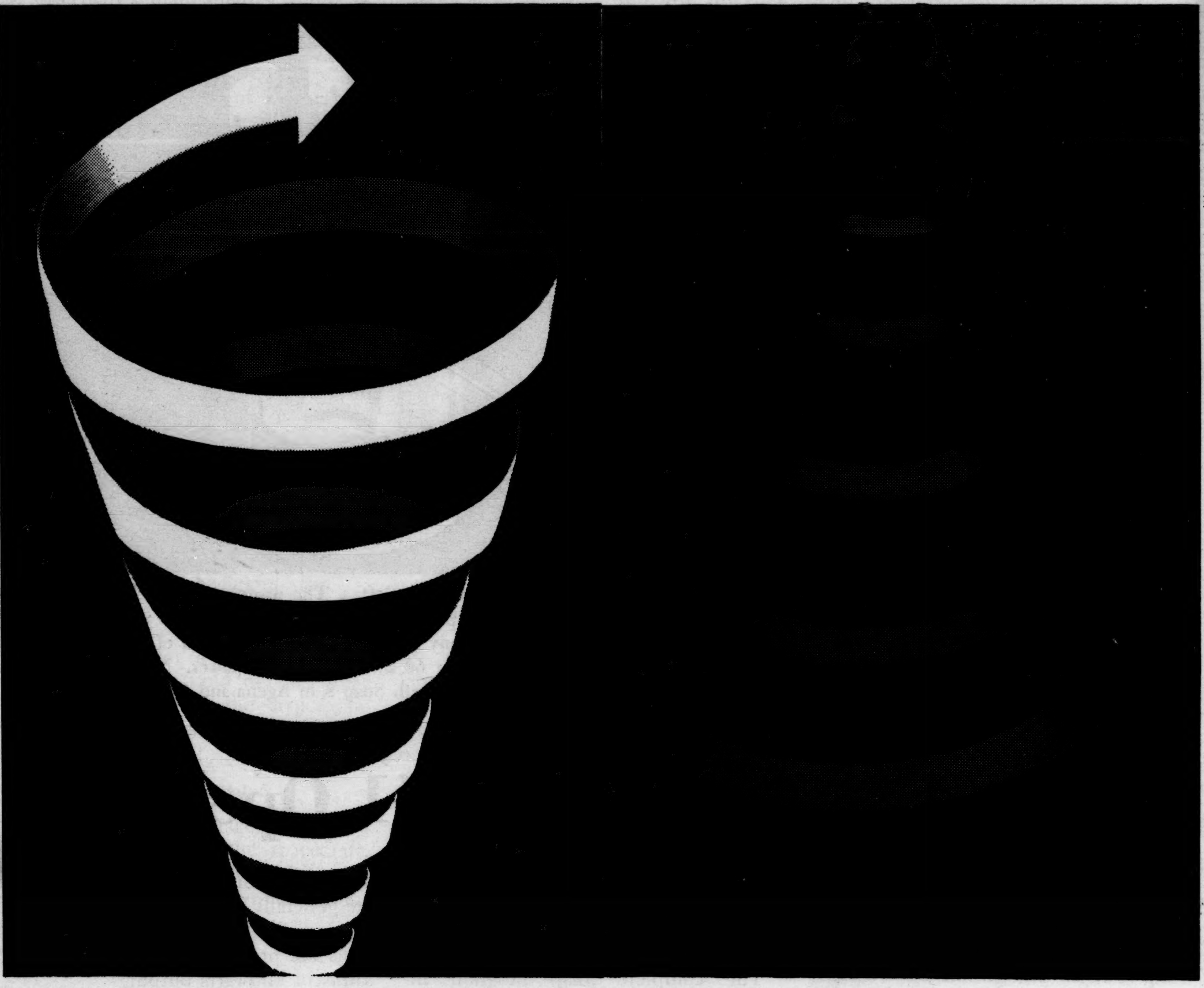
The Nuclear Division of the Martin Co. was awarded a contract to develop radioisotope power sources for space use, and Atomics International, a division of North American Aviation, Inc., won a competition to develop a compact core for auxiliary nuclear power systems for space vehicles. Each company began work in 1955.

Six major Snap units have grown out of these contracts. Three of the units use a radioisotope heat source, and three use a reactor.

- **Snap 1.** In 1955, the first problem for this unit was to select a suitable fuel from among several hundred possible radioisotopes, which come from two main sources. One type of radioisotope produces beta rays and is a waste product from the fission reactor, and the other is an alpha emitter which is produced by irradiating certain materials in a reactor.

The main requirements for a radioisotope fuel is a half-life of 100 days or better and a thermal output greater than 0.01 watts per gram. This is to ensure that over a long period of time the isotope will continue to emit particular and electromagnetic radiation which will raise the temperature of the



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material containing the isotope and provide a heat source. To keep the heat source to a practical size, the isotope's thermal output per gram must be high. Six isotopes met the fuel requirements, and of these, cerium-144 was selected because of its availability. There has generally been a limited quantity of radioisotopes suitable for fuel use because of a shortage of facilities needed to separate and process them to the proper state of purity.

Snap 1 Power Output

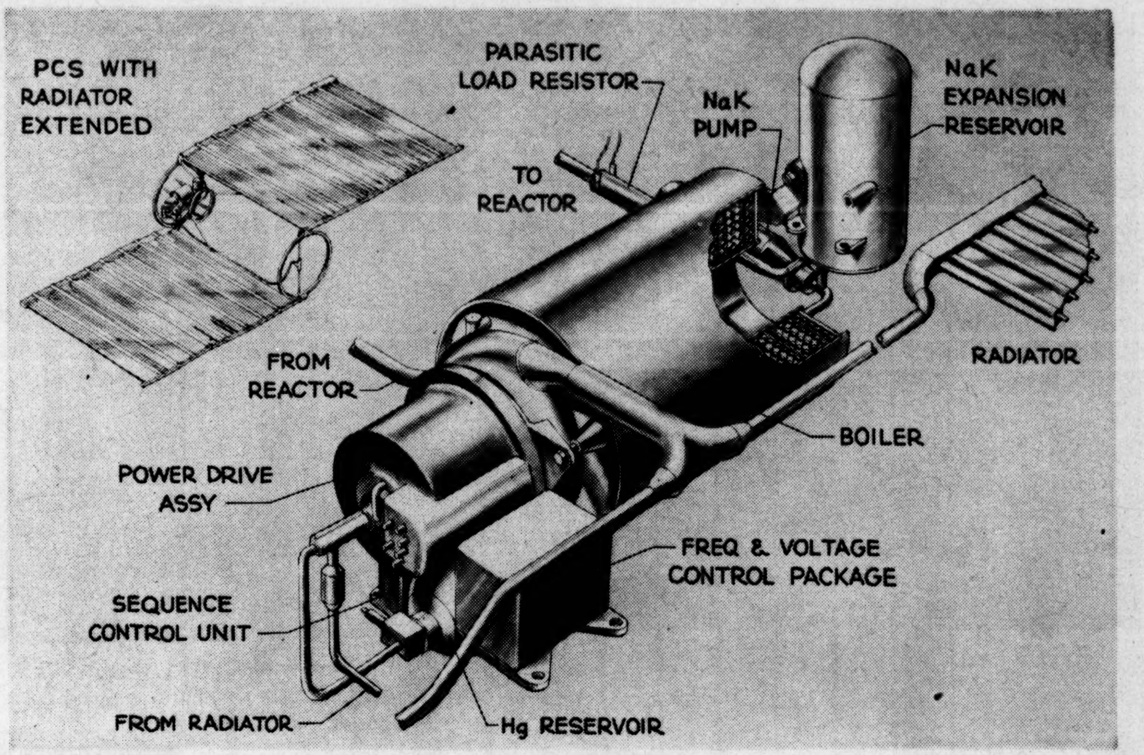
Powerplant specifications for Snap 1 were firmed up in 1957 at 500 watts electrical output for 60 days. A turbogenerator was selected to deliver the electrical power because it was considered the best conversion technique then available.

The turbogenerator design selected represented an advance in this field, however, because all the moving parts in the system were connected to one high speed shaft which was lubricated by its liquid mercury working fluid. To raise its reliability, no auxiliary pumps or other systems were used in this unit.

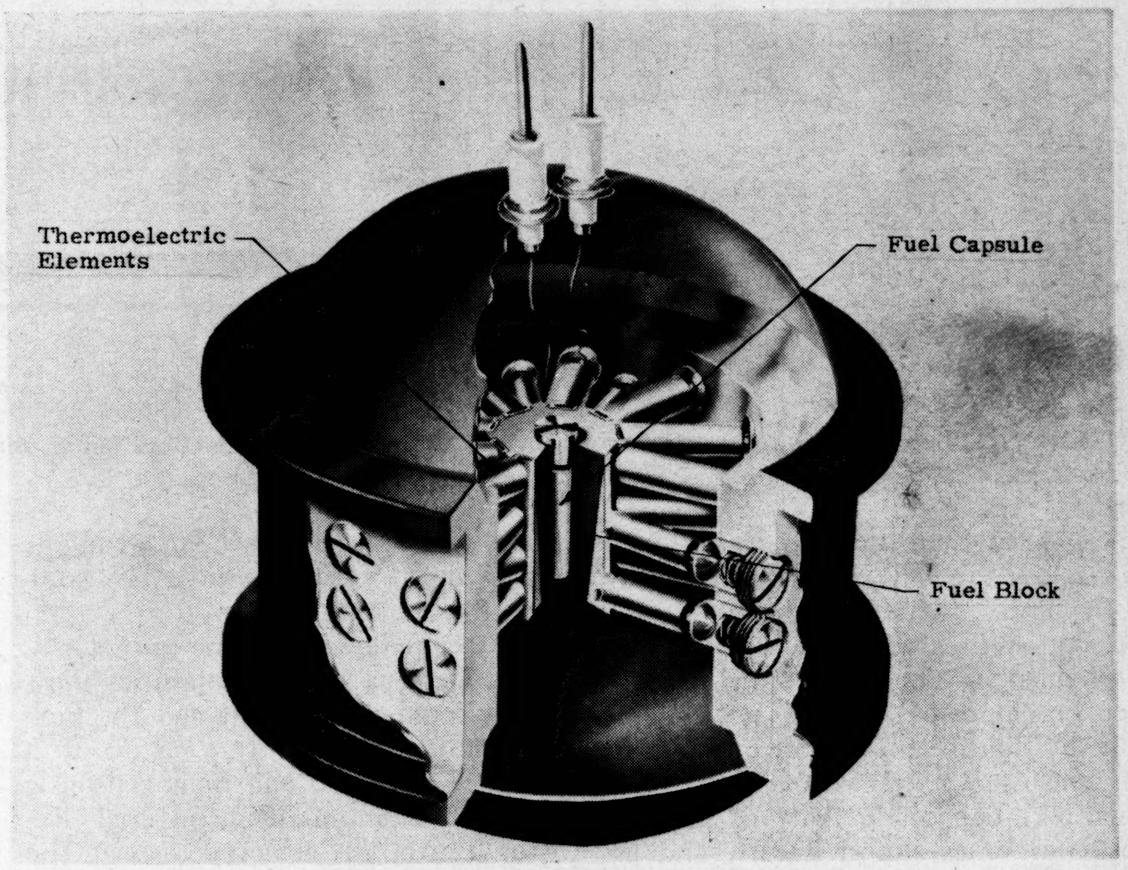
Heat source in the system was to be a metal block in the shape of a right circular cylinder containing the cerium-144 about 1-ft. long and 4 in. in diameter. The liquid mercury was to be boiled as it passed through this hot block, and the vapor was to be expanded through the turbine driving the electric generator.

The turbogenerator conversion system was developed by Thompson Ramo Wooldridge. A complete turbogenerator package was delivered by the company in 1958, and it was operated far in excess of the original specifications.

This unit will not be used with the Snap 1 heat source, however, and it was transferred in the spring of 1959 to the reactor portion of the Snap program along with the technology developed with it. This re-orientation of the Snap 1 project and the transfer of its original energy conversion system was decided upon because of an improvement in the technology of thermoelectric heat-to-electricity conversion devices with no moving parts.



SNAP 8 power conversion system is shown in drawing above.



SNAP 3 experimental unit has proved the feasibility of radioisotope power systems.

Energy Conversion Techniques

- **Snap 3.** Basic research in advanced energy conversion techniques began in 1955 under the Snap program. The two main techniques studied were thermoelectric and thermionic, neither of which required moving parts, thus allowing entirely static power systems. Thermoelectric materials develop an electrical potential if there is a difference in temperature within the material. Thermionic conversion operates on the same principle as the vacuum tube. Heat is applied to a cathode which boils away electrons that flow to a cold anode, establishing an electromotive force between the two surfaces.

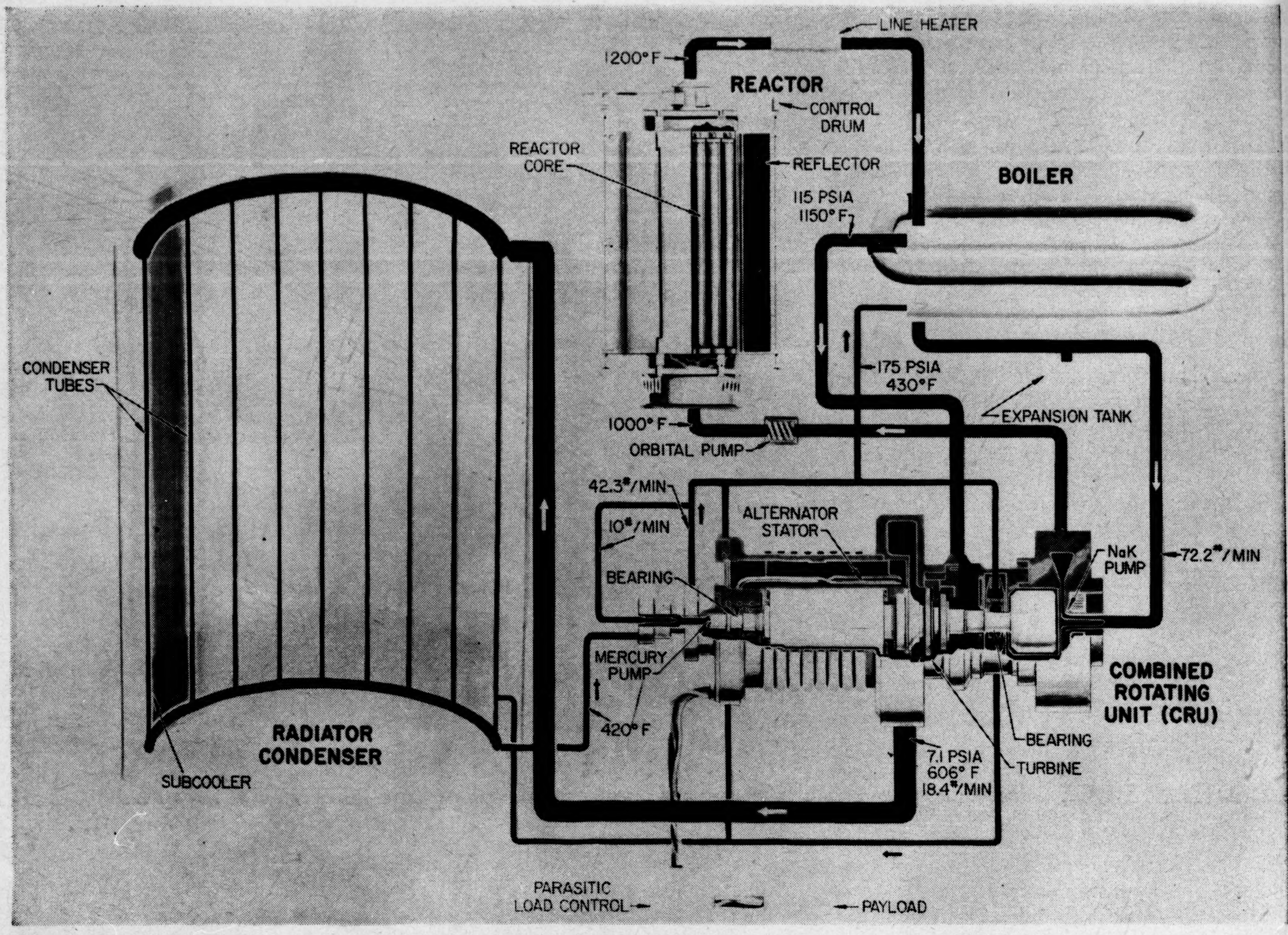
Work with these and other advanced devices had progressed so well by 1958 that a separate project, Snap 3, was formed to develop and demonstrate their potential.

Two contracts were let at the beginning of 1958 for thermo-electric demonstration devices, one to the Westinghouse Electric Corp. and the other to Minnesota Mining and Manufacturing Co.

Quick results were achieved, and the Minnesota Mining and Manufacturing Co. delivered a complete thermoelectric generator by December, 1958. Polonium-210 fuel capsules were installed in the generator, and this proof-of-principle device was shown to the public as the Snap 3 "atomic battery" by President Eisenhower on Jan. 16, 1959. It produced 2.5 watts with a half-charge of fuel.

- **Snap 1-A.** The successful thermoelectric research work in the Snap 3 project was used immediately. Snap 1 was reoriented and became Snap 1-A. The original fuel cylinder remained the same, but it was surrounded by a double-wall outer skin which contains liquid mercury for shielding purposes. The small thermoelectric elements are attached to this skin and interconnected so that they will deliver 250 watts continuously for a year. Final tests of Snap 1-A are scheduled early next year.

An important element in any radioisotope unit producing constant power is a self-regulating device to dump varying quantities of heat. The radioactive



SCHEMATIC of the Snap 2 turbogenerator which will deliver 3 kw. of electrical power using the 50 thermal kw. supplied by the reactor is shown above. The complete Snap 2 reactor-converter unit will weigh about 600 lb.

energy decay of the fuel is not constant, and it falls off logarithmically with time. Therefore the excess heat present during the early life of the unit must be dumped. A method under development controls power output by adjusting the gas pressure in an enclosure filled with a porous insulation. The conductivity of such an insulator varies almost linearly and inversely with the gas pressure, and this is controlled by a valving system which requires no power and allows gas to escape to space as the cold-junction temperature of the thermoelectric material decreases.

The rapid development of radioisotope power unit technology in the Snap program has greatly encouraged nuclear engineers and has generated many new ideas. Isotope power is being considered today for a wide variety of military and civilian equipment that must have power sources that do not require attention for very long periods of time. Typical of these are unmanned arctic weather stations and marker buoys on and beneath the surface of the sea.

- **Snap 2.** Competition for development of a very compact nuclear reactor producing 50 kw. of thermal heat from a core volume of about 0.3 cu. ft. was initiated in 1955. Atomics International was awarded this contract in the spring of 1956 from among 13 companies submitting bids.

To keep the size of the unit down, liquid metal, a sodium potassium alloy, was selected as a coolant and the fuel-moderator elements were made of a massively hydrided and homogeneously mixed zirconium-uranium material. Reactor control was achieved through the rotation of small drums unequally loaded with boron around their periphery. The control drums were located in the neutron reflector surrounding the core. Weight of the complete reactor is 200 lb.

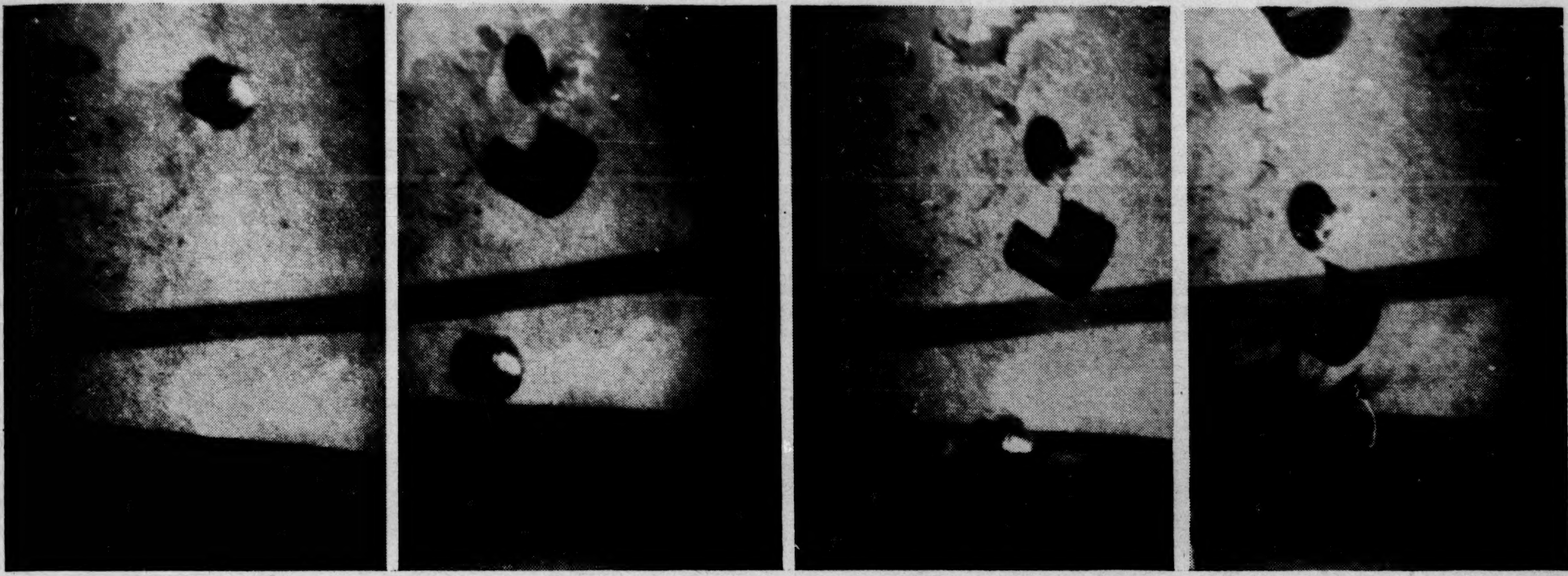
A prototype Snap 2 reactor of the type has been under test for some time. Its coolant outlet temperature is 1,200F, and it delivers about 50 thermal kw. Through August of this year, the core had operated for 153,000 kw. hr., including a continuous full-power run for 1,000 hr.

Energy conversion equipment for the Snap 2 unit proceeded in parallel with the reactor work. The unit selected was a mercury vapor turbogenerator system similar to the one originally planned for Snap 1. Both of these mercury vapor systems were contracted to the same company, Thompson Ramo Wooldridge. In the course of development of both systems, several combined rotating units—with the mercury turbine, electric alternator, and mercury and liquid metal pumps all on one shaft—have been built and tested.

Mercury has been selected for current Snap power conversion systems because it is the only liquid for which there is enough engineering data in the right temperature to permit the development of a very-long-life system. The basic mercury data now available is being used in an extensive program to determine its boiling and condensing heat transfer, corrosion and mass transfer properties. This data is vital to the detailed design of the dual loop liquid metal-to-mercury boiler, or heat exchanger, and the mercury radiator or condenser.

Design of the mercury radiator must be integrated into the space vehicle design to an extremely close degree to ensure positive fluid condensation under zero gravity conditions when even a low torque produced by the vehicle is of great importance. The combined radiator and vehicle design must also consider reducing the danger of puncture by micrometeorites. One of the Snap 2 integrated satellite designs is shown on page 75.

There are several other areas in



EXPERIMENTAL radioisotope-thermoelectric power unit (Snap-3) is being fired at a speed of 342 fps. into a rock-like material made up of 80% earth and 20% concrete. These firings failed to break open the container. The band following the container apparently is the sabot to hold it while it was fired.

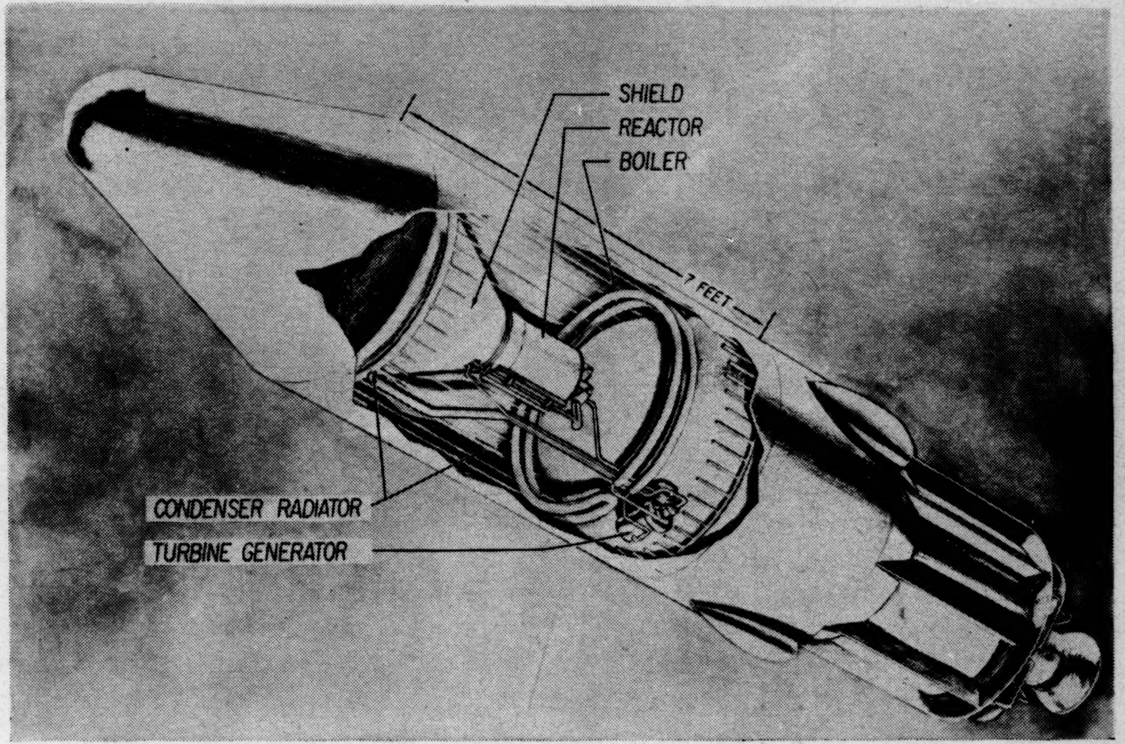
which vehicle and powerplant design must be coordinated closely. These include the complete system dynamic responses to ensure remote start-up in orbit and the integration of shielding for equipment and the main structure to achieve minimum weight.

These requirements and the specification for trouble-free unattended operation for a year or more cannot be satisfied unless a large amount of ground testing is done on all components and on the complete system under as close an approximation of the space environment as possible. The component tests are under way now, and the complete system tests will be conducted in the Snap Environmental Test Facility (SETF), which has just begun operation at Santa Susanna, Calif. Atomics International Division of North American Aviation operates it for AEC.

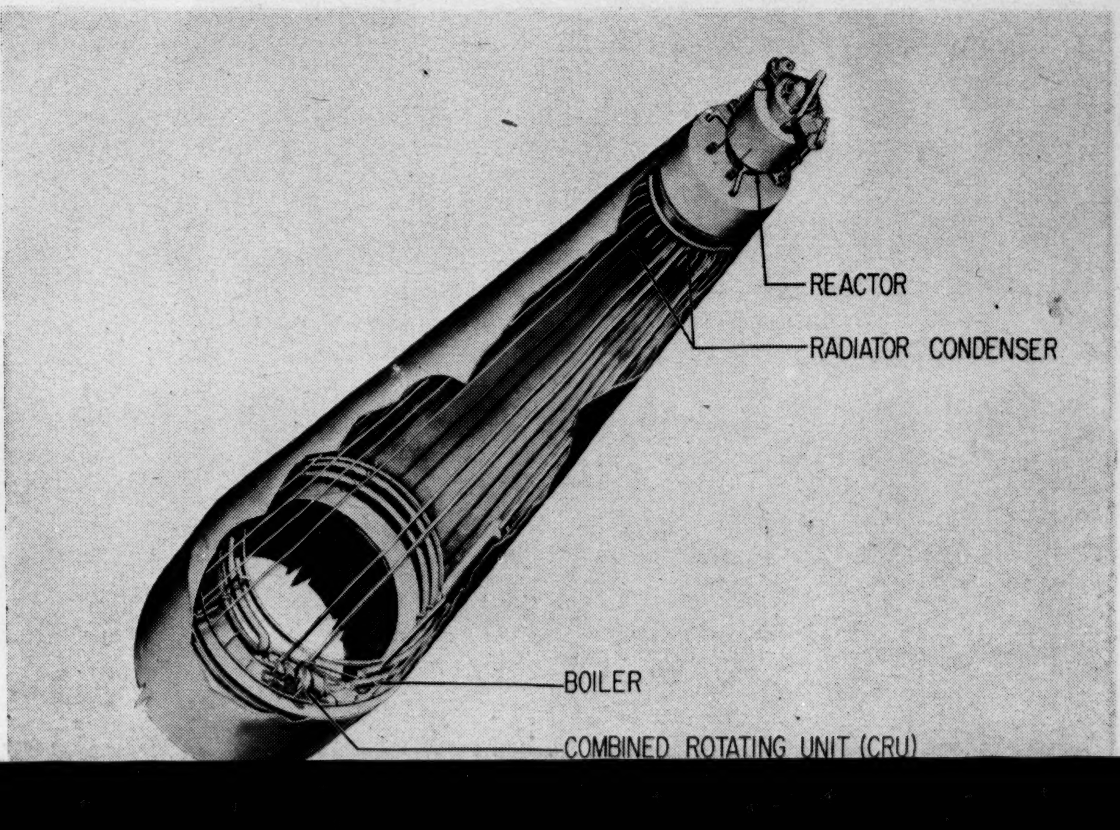
Two main test vaults have been provided in this facility to allow full-power nuclear operation of Snap-powered vehicles. Normal operation consists of a nuclear test in one vault while the other houses a test rig that has just completed test and is being removed for examination and the vault is being decontaminated and made ready for the next test.

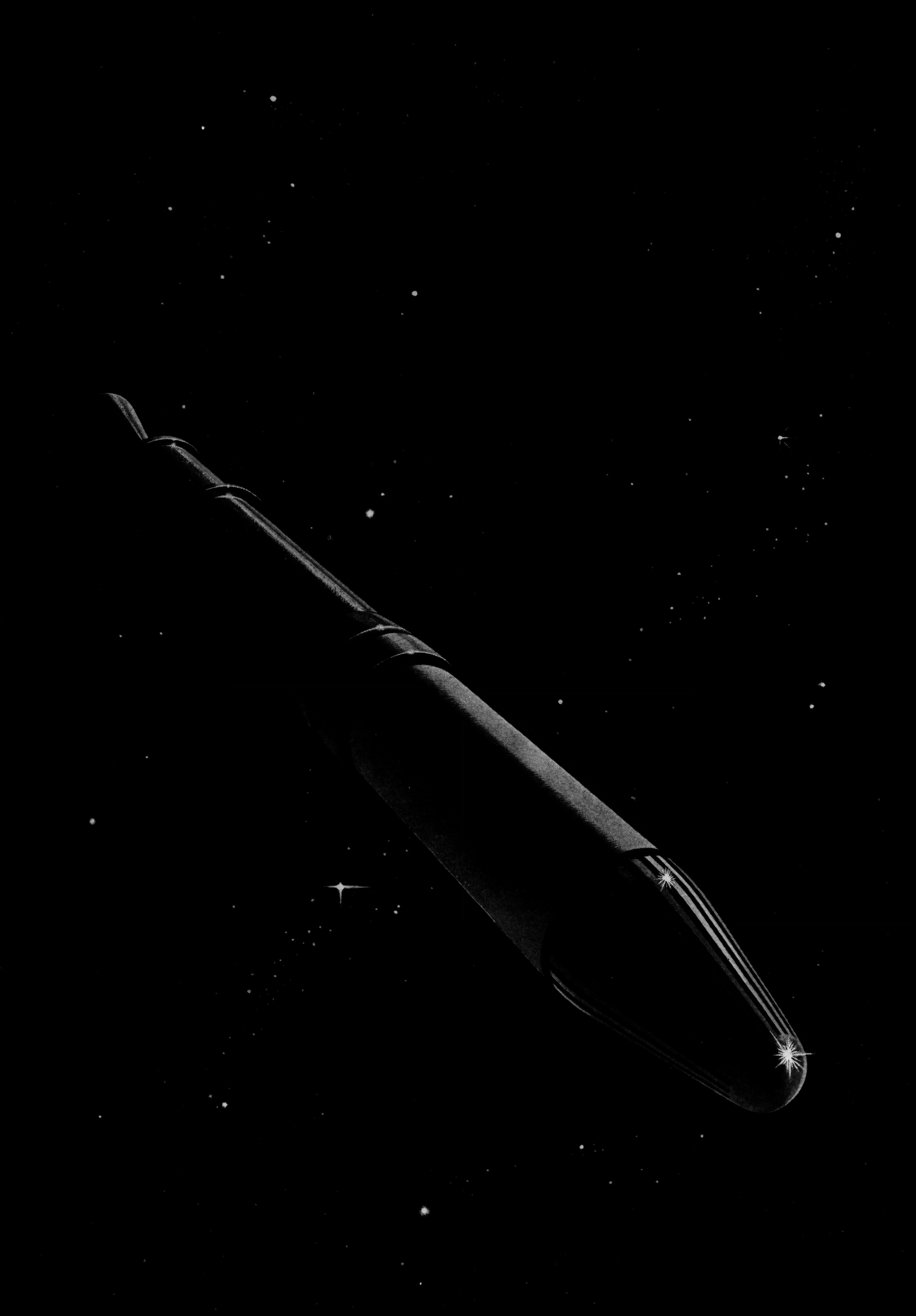
The first test in the facility is just beginning and will continue for about one year. This test, S2-DS-1, (Snap 2, Developmental System -1) is being made with a Snap 2 reactor separated from the power conversion system by a shield. Its purpose is to determine control and component response data which can only be obtained with such shielding. Final design of the Snap 2 unit components cannot begin until this response data is available.

The next complete system test (S2-DS-2) is scheduled to begin in the summer of 1962 and will test a Snap 2 in its final space vehicle configuration with the reactor closely coupled to the system components. The nuclear portion



SNAP 2 reactor as it would be installed in the USAF Midas early warning or Samos reconnaissance satellites. Main components are the 50,000-watt thermal liquid metal cooled reactor, a boiler-superheater, a turbine, a condenser-radiator and an alternator. Snap power units will have to be integrated closely into design of any given space vehicle. Nose cone type installation of the Snap 2 reactor is shown above with radiator tubes lining sides of the structure. The exposed position of the reactor on the front of the nose cone would assure that it burned up and disintegrated during an unscheduled re-entry into the atmosphere.





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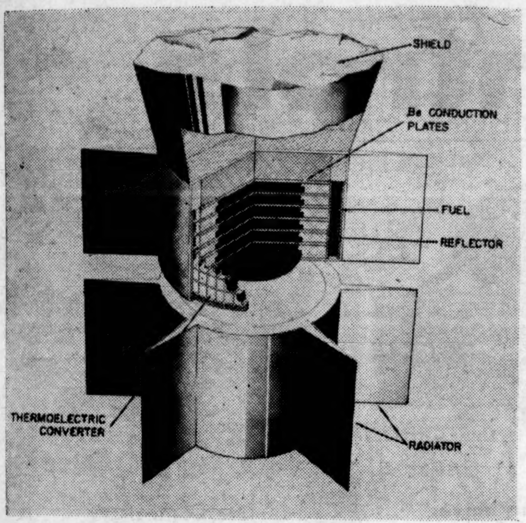

CONSTRUCTION of the Snap 10 reactor, which is surrounded by thermoelectric energy converters and by large radiator fins to conduct away the excess heat.

of this test is intended to confirm the performance of the system.

The third of the Snap 2 tests is scheduled to begin in the summer of 1963, and it is designated S2-PS-1 (Snap 2, Package System -1). This will be a ground demonstration of a flight prototype system. Flight demonstration itself could be performed during 1964 under this schedule. Officials of the Snap project believe that this series of three nuclear tests is the absolute minimum needed to ensure the unprecedented reliability called for in Snap 2 specifications.

- **Snap 8** has been described by AEC officials as an enlarged, scaled-up version of the Snap 2. The Snap 8 reactor will weigh 300 lb. and produce 600 thermal kw. compared with 50 kw. for the Snap 2. This will allow the unit to drive either one or two 30-kw. output turboelectric units. Total output of the combined unit can then be 60 electrical kw. Planned uses of the first Snap 8 unit include supplying the power for the first ion engine tested in orbit.
- **Snap 10** combines a reactor with thermoelectric elements to provide a completely static power unit with a 300 electrical watt output. First complete system test is scheduled for early 1961. No control drums are required to control this reactor because it has a strong negative temperature coefficient which reduces its power output when the temperature rises above an unsafe level. Its lifetime is predicted to be one to three years before the negative temperature coefficient becomes so large that the reactor will shut itself down.

Starting of the Snap 10 reactor will take place in space simply by actuating a mechanism which will push the two halves of the core together. The thermoelectric power conversion elements are arranged around the core (see p. 73). The whole unit is cooled by conduction of heat to a set of fins around its outer surface.

Total weight is 350 lb. One of the

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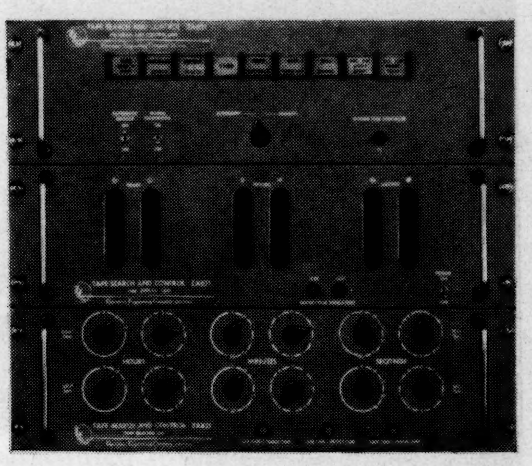

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main advantages of the Snap 10 unit is that it does not have to be oriented toward the sun and it will continue to operate if it stays in the shadow of the earth for a long period. The solar cells and solar mirrors which are competing in the Snap 10 power range are not this versatile.

Snap units operate in the thermal neutron energy range which until recently has been beyond the capability of small reactors. In the past, minimum volume cores have been feasible only for reactors whose fission reaction was sustained by fast neutrons of much greater strength than the thermals. The disadvantage of fast reactors has been their large fuel requirement, which drove their cost much higher than that of the thermal reactors.

The small thermal cores of the Snap units have been made possible by the development of massively hydrided zirconium-uranium fuel moderator material. Snap 2 and 10 will use slightly less than three kilograms of enriched uranium and Snap 8 about five kilograms, which are major reductions in the fuel requirement compared with a fast reactor. The system weights quoted here for Snap reactor units do not include any shield weights. Shield requirements will vary with reactor output, and with the composition and location of the payload. Humans will be the most sensitive to the Snap radiation, with electronic equipment next. Most equipment in a space vehicle will not be particularly effected by the Snap radiation level.

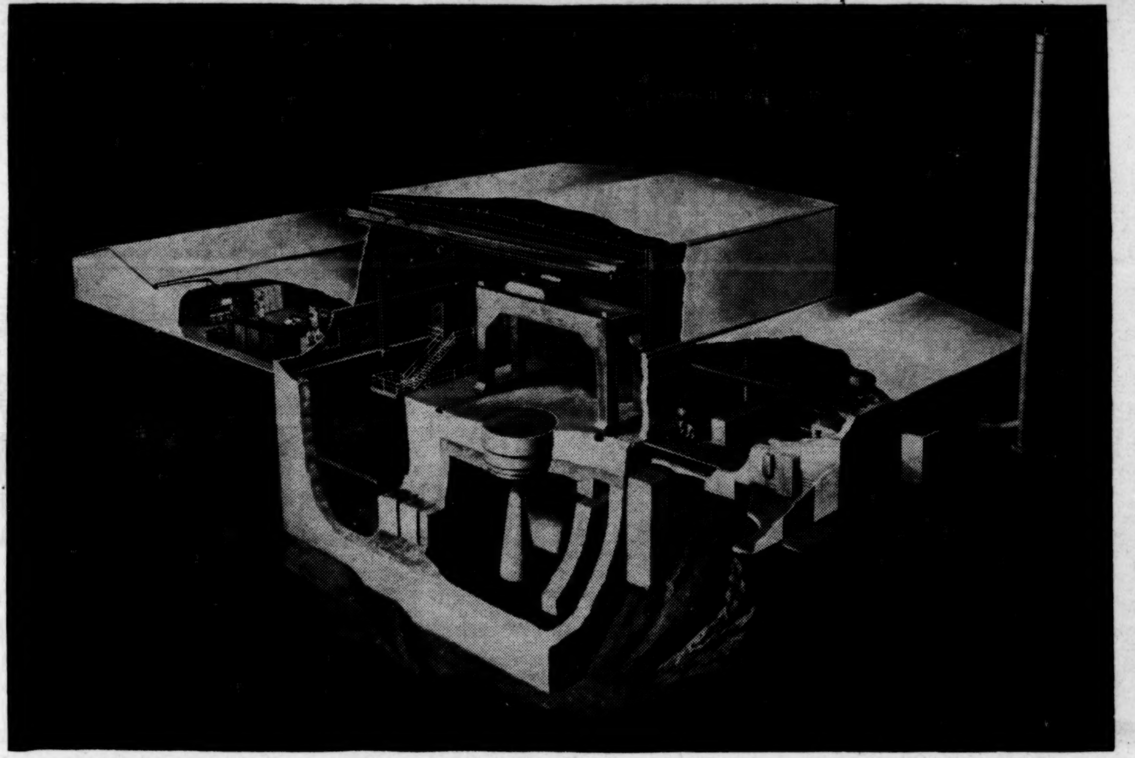
Primary Shielding Concepts

Two main shielding concepts will be used on space vehicles separation and shadow shielding. Some vehicles carrying large quantities of electronic equipment driven by a Snap unit probably will have the reactor and payload at opposite ends of a 30- or 40-ft. tube.

A shadow shield would be placed closely in front of the reactor, creating a cone of reduced radiation in the direction of the payload. Shadow shielding works well in space because there are no air particles to scatter the radiation around the shield.

When humans are carried in the same space vehicle with a large Snap reactor, the lightest shielding arrangement probably will use a long cable to separate the reactor from the crew section. Heavy shadow shielding would also be used with this system.

The task of sending nuclear isotopes and fissionable material into orbit has raised many safety questions, primarily concerning catastrophic failure of the launching rocket. Two general design methods are being used to prevent the release of any radioactive or fissionable material into the atmosphere during a launching or re-entry.



ENVIRONMENTAL test facility in which the Snap power units will be subjected to as close a simulation of the space environment as possible is shown in the cutaway drawing above. Facility is called Snap Environmental Test Facility (SETF) and has just begun operations. Two main test vaults have been provided permitting full-power nuclear operation of Snap-powered vehicles.

The first method is to house the radioactive material in a heavy, safe-like container which is essentially indestructable by any of the forces which could conceivably be present during a rocket launching or re-entry. The second is to design the structure of the nuclear system only to resist the loads it will receive during normal operation. With this design, the nuclear system will have to have an escape system similar to that required for a man if fissionable material is not to be spread over a large area in a space vehicle accident.

The heavy safe-like container has been used for the radioisotope power units because they must be completely enclosed by heavy shielding under all circumstances, and there was an opportunity to save some weight by making the shield resistant to fire, explosion and impact. The second approach to safety has been used with the Snap reactor systems because they will not require heavy shielding, even during their operation in space. On the ground, they will not be radioactive because they will not start producing power until they reach orbit. An escape rocket system probably will be used to catapult any reactor, except for a reactor in the main rocket powerplant, clear of its booster vehicle if trouble should develop during a launch.

The reactor will not have a heat shield and will be in an exposed position (see p. 75). Although the reactor would be covered by a light fairing during the flight in the atmosphere, the whole system would burn up upon reentry into the atmosphere after ICBM or even IRBM speeds were reached. Before those speeds were attained, the reactor would be catapulted free and parachuted to the ground if the booster rocket failed.

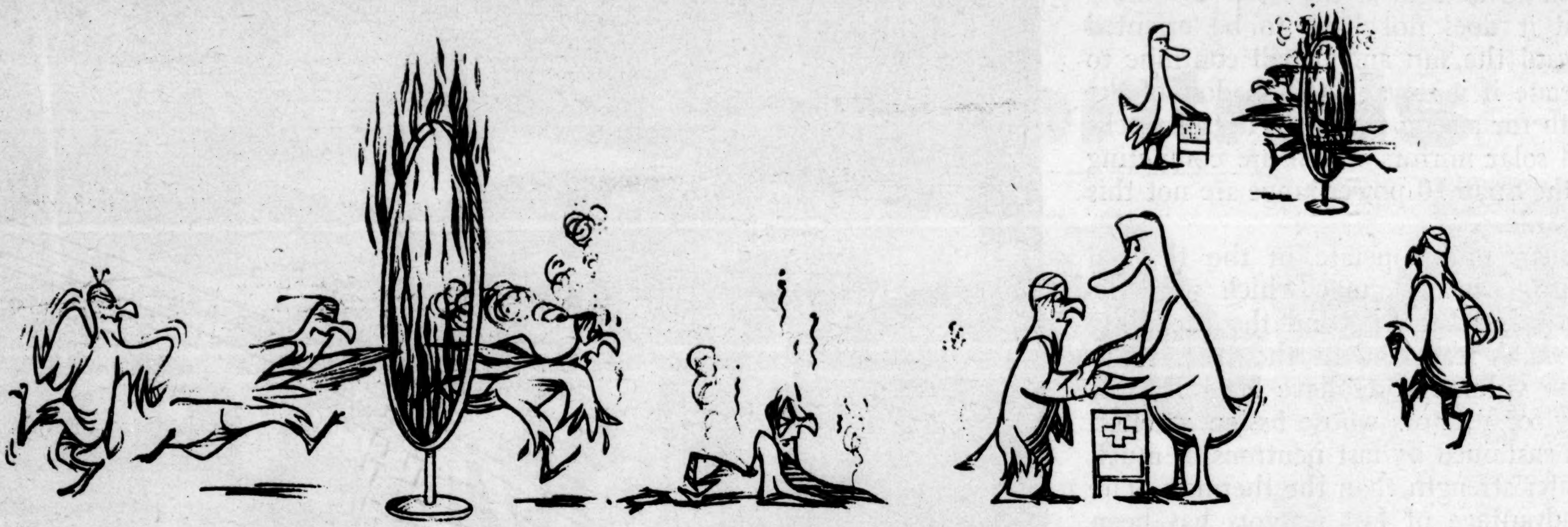
The Martin Co. has performed some elaborate tests to qualify the container for its isotope fuel. The Snap 3 container, which is a typical design, consists of a heavy metal, slightly tapered cylinder with an over-all length of 2⅛ in.

The isotope load is placed in two small stainless steel containers which fit inside a larger stainless steel container. This unit then fits inside the outer cylinder made of flame-coated molybdenum. All of the stainless steel containers are welded together with full penetration welds, and they are secured in the outer cylinder with a tapered plug.

Safety Testing

During safety testing, the Snap 3 isotope container was placed in the center of a large quantity of rocket fuel that was exploded and set afire with no change in its integrity. It was fired into a mixture of 80% earth and 20% concrete at a velocity of 342 fps. (see p. 75) without damage. The qualification tests also included heating the container to temperatures it would experience during a maximum speed reentry and then firing it into a tank of water to simulate a sea impact. The resulting thermal shock failed to harm the container.

These tests were believed to equal or exceed any stress the container might encounter during its life. The successful completion of the tests has led to great confidence in the isotope power unit design from a safety standpoint.



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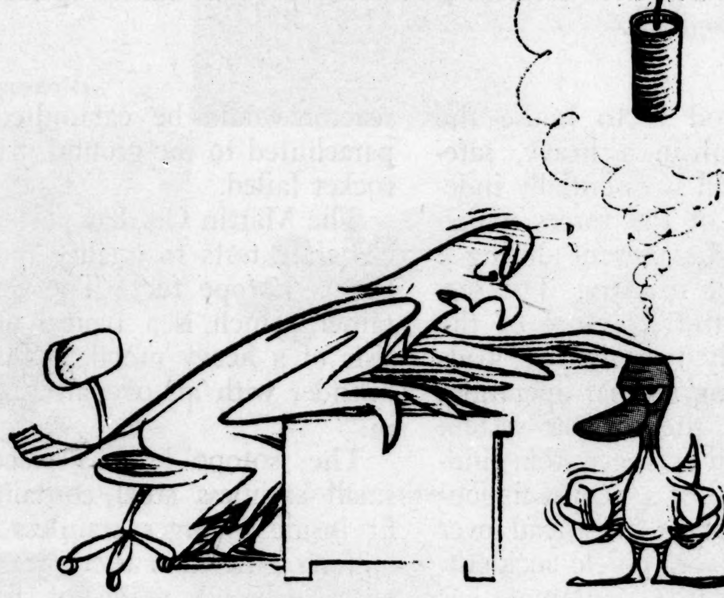

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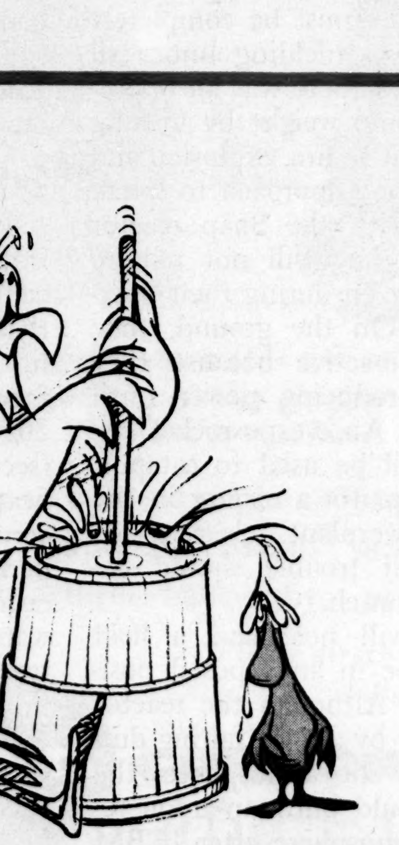
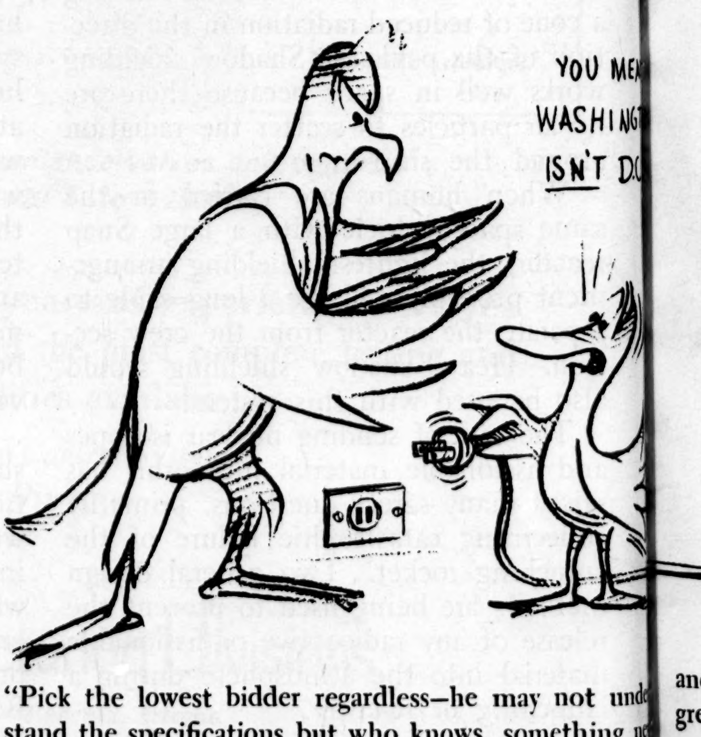
Benson and Roberts, whose "Engineersmanship" was a unique contribution to games theory, have put together a new volume under the engaging title above, aimed with the subtlety of a Skybolted B-52H against the policies of a government sponsoring research and development.

Students of Stephen Potter will recognize extrapolations of his basic theories. The book is divided into four collections: Useful ploys for emergency use, useful ploys to



"Government-sponsored research and development is like the dairy business: If you keep churning long enough you're bound to get butter. You wouldn't want a half million engineers to turn sour, would you?"



"Pick the lowest bidder regardless—he may not und
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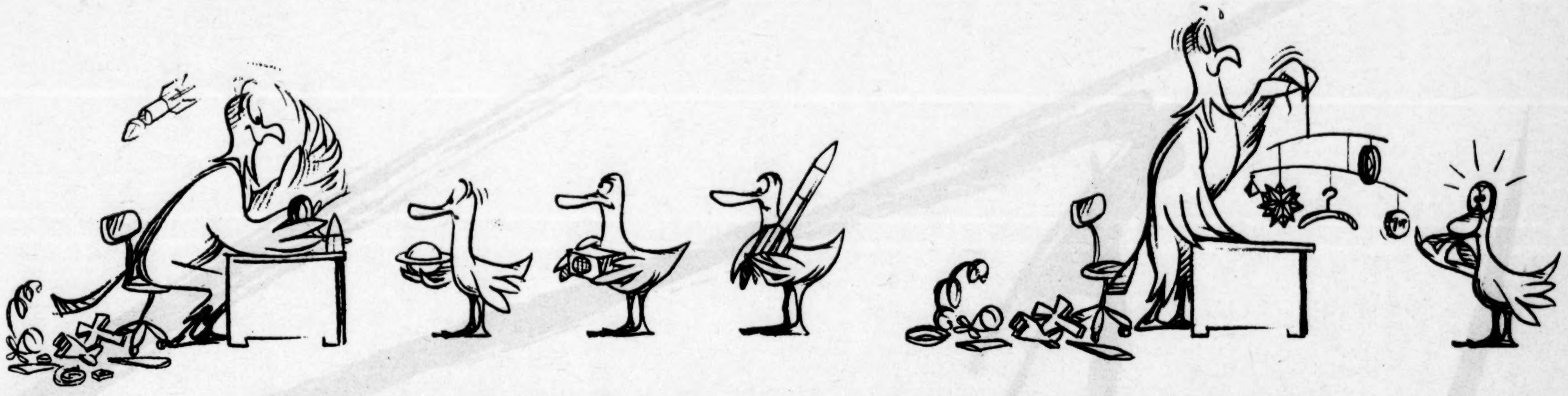


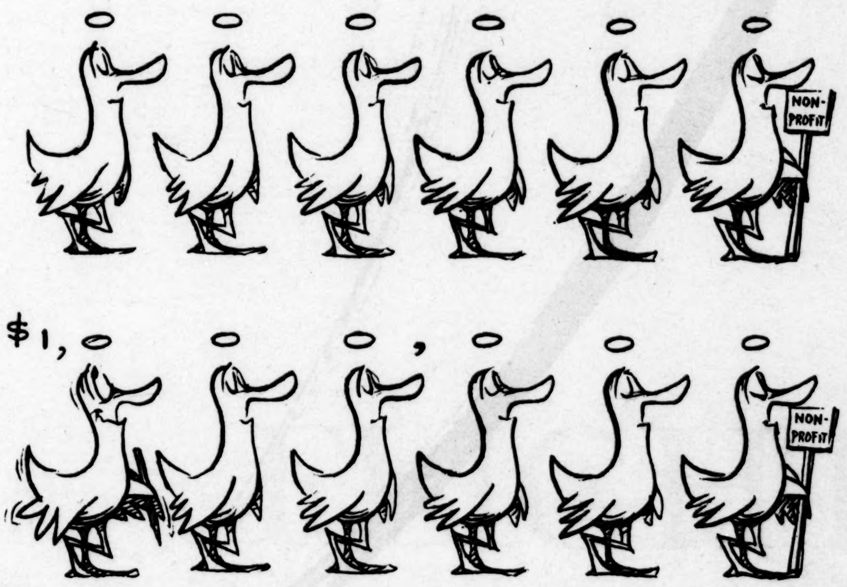
"Creative engineering is available for free—just get in a flock of proposals, take the best out of each, and go out again for bids on a 'revised' specification. This gives everyone a feeling of belonging, which is the basis of all creativity."

Birdsmanship

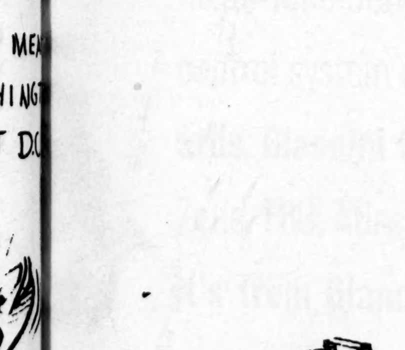
protect against capitalism, useful ploys to keep industry alert, and useful ploys to protect industry against itself. Benson, born and raised in Britain but now a naturalized U. S. citizen, is a former Royal Air Force pilot and founder and head of Benson-Lehner Corp. His background includes invention of the first British acoustic homing torpedo and initiation of the British Air Ministry's guided missiles program.

Roberts, creative director and a principal of Carson/Roberts advertising agency, is a former USAAF pilot who flew in the South Pacific theater.

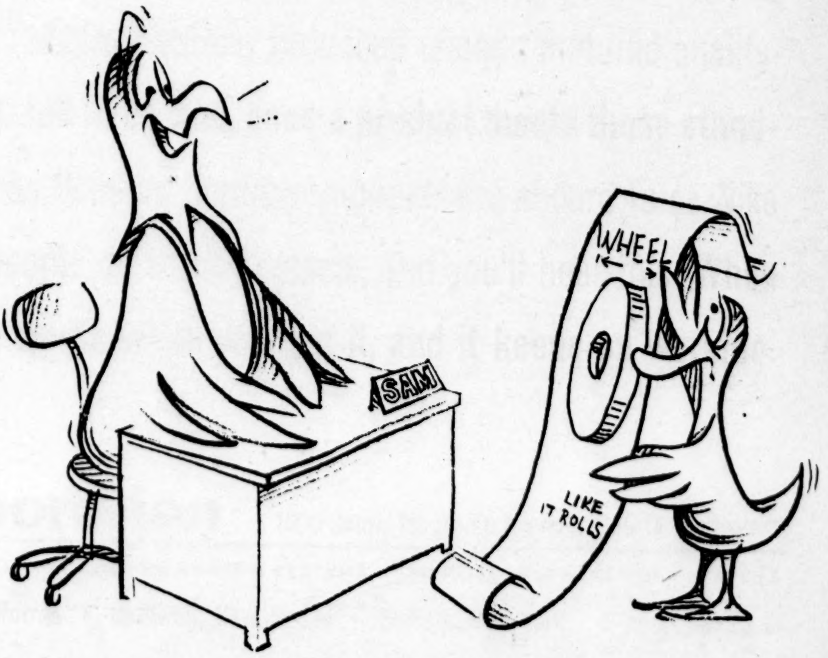
"Strictly Birdsmanship" may be purchased directly from Benson-Lehner, 1860 Franklin St., Santa Monica, Calif.



"Nonprofit corporations are a tremendous step forward in government procurement efficiency. Why allow profits when it costs so much to get them back in renegotiation and taxes? Why rob Peter to pay Paul if Peter isn't even in the act anymore? Why not incorporate for nonprofit just for the halo of it?"



and exciting may come out of it—some of the world's greatest men were born because of mistakes."



"Tremendous idea—come back when the Russians have done it and we'll be able to get it sponsored with no trouble at all."

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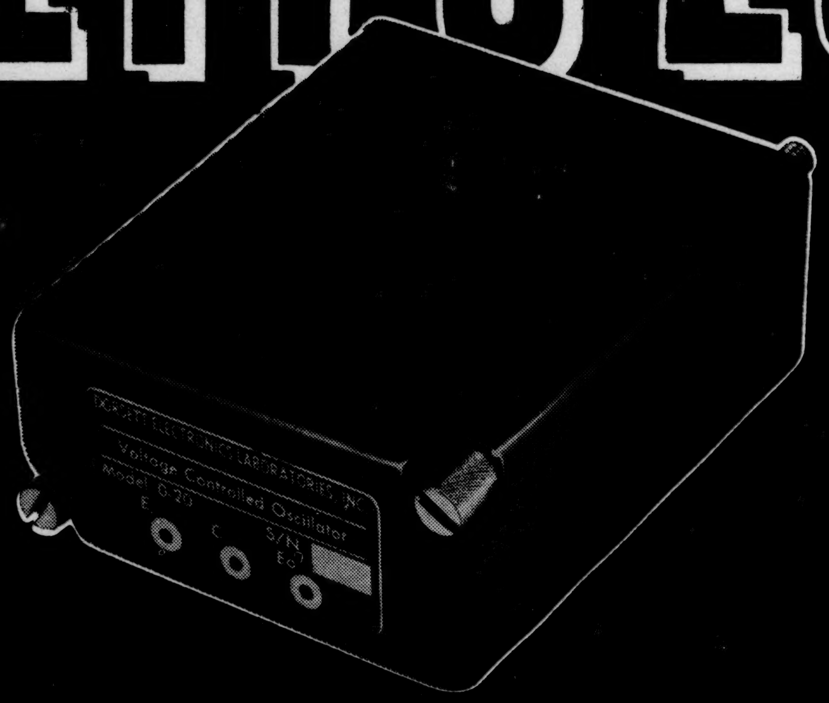
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Nuclear Rocket Foreseen as Saturn Stage

By Erwin J. Bulban

Dallas, Tex.—An urgent and dynamic nuclear propulsion program that in the decade ahead will enhance this country's capabilities and move us quickly into a position of positively leading and staying ahead of the Soviets was described recently at the American Astronautical Society's seventh annual meeting.

Harold B. Finger, manager, Atomic Energy Commission-National Aeronautics and Space Administration nuclear propulsion office, delineated steps which he said will have early applicability and will provide a firm foundation of propulsion sources for future decades of space programs.

The milestones Finger outlined are:

- **Nuclear rocket propulsion** systems, which he believes will be available first, are seen as replacing the third stage of a chemical Saturn vehicle to give the capability of an earth escape payload of two or three times the payload possible with a chemical Saturn. Such a nuclear propulsion system can provide a back-up in the Saturn aimed at manned circumlunar flight programed for the end of this decade. In this system, liquid hydrogen is heated to high temperatures in a reactor, generating jet velocities and specific impulses two or three times those attainable by combustion of even high-energy chemical propellant systems, he said.

Liquid Hydrogen Propellant

Finger noted that the Kiwi-B series of tests to be started later this year will use liquid hydrogen as a propellant and as a coolant of all critical parts including the nozzle, just as is planned for the operational rocket system. This Kiwi-B program will establish the design of a rocket reactor suitable for incorporation into a flight test engine. Design and development of all components required for the Kiwi-B tests are under way and on schedule, he stated. The test cell used in the Kiwi-A experiments is now being modified to provide it with a liquid hydrogen capability for use in the Kiwi-B series and a second liquid hydrogen test cell is well under way. These facilities utilize an upward-firing test cell to simplify the installation, but the first downward-firing ground test cell capable of use in an engine development program for a flight test system is now being designed, he said.

- **Electrical propulsion systems** are the subject of an enlarged program and plans are now being prepared to conduct a battery-powered ion accelerator flight test, probably using an Atlas-Agena vehicle, to evaluate beam neutralization late in 1962. This evaluation is considered necessary because true simulation of beam neutralization problems, whereby the high velocity, positively charged ion beam builds up a space charge which decreases the jet velocity, cannot be achieved in ground test facilities, although many experiments have been made in a vacuum in the laboratory.

Finger pointed out that although much work is being done on electric propulsion devices, he is convinced that the feasibility of such systems depends on the systems that generate the electrical power rather than on the accelerator devices that utilize the power.

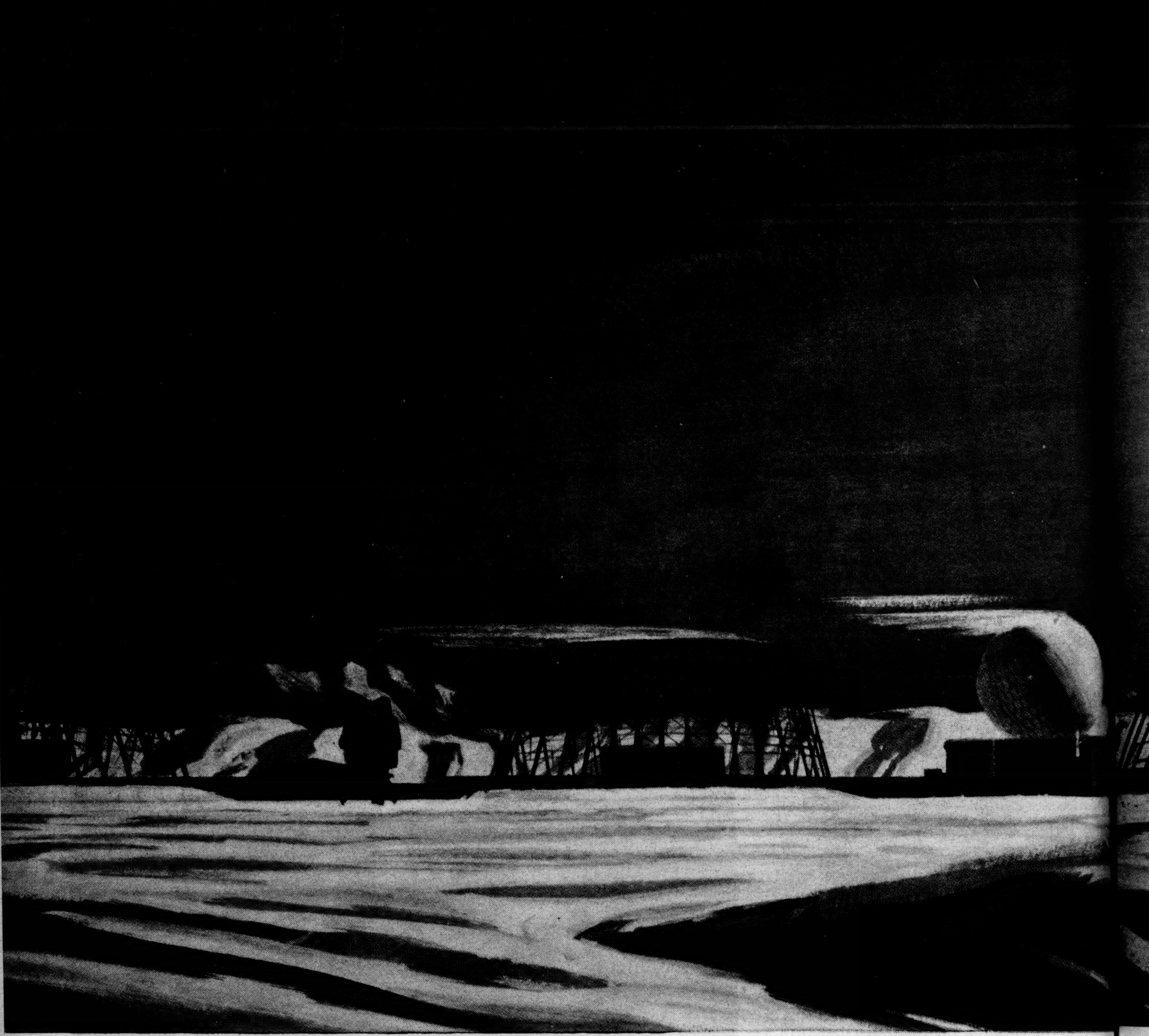
It is essential, he stated, that for large payload missions, specific powerplant weights of approximately 10 lb. of engine power per electrical kilowatt must be achieved. Such electrical generating powerplant weights require use of high temperature, long-life, liquid metal and metal vapor working fluids and there is practically no experimental information regarding the properties of these materials at temperatures above 1,500F and on the operating characteristics of the components that will be required. Temperatures of approximately 2,700F are required to achieve sufficiently low specific weights, he pointed out, and therefore fundamental data must be developed before major hardware developments of high-powered systems suitable for electrical propulsion can be undertaken, he said.

One area of electrical propulsion that is setting the stage for development of high-power systems is the joint AEC-NASA 30-60 electrical kilowatt Snap 8 nuclear reactor electric power system, which, however, requires a flat plate radiator area of some 600 sq. ft. to disperse waste heat. Integrity of such a radiator in space is a major design

Ocean Launching Platform Proposed by Aerojet

PROP, Planetary Rocket Ocean Platform, has been proposed by Aerojet-General as a means of launching large chemical and nuclear boosters from the high seas. Company's Aetron Division has been assigned responsibility for the projected platform. Artist's drawing shows nuclear rocket ship, readied for launch. Submerged buoyant chambers lift platform well above high seas.

CREATIVE ELECTRONICS BY RCA



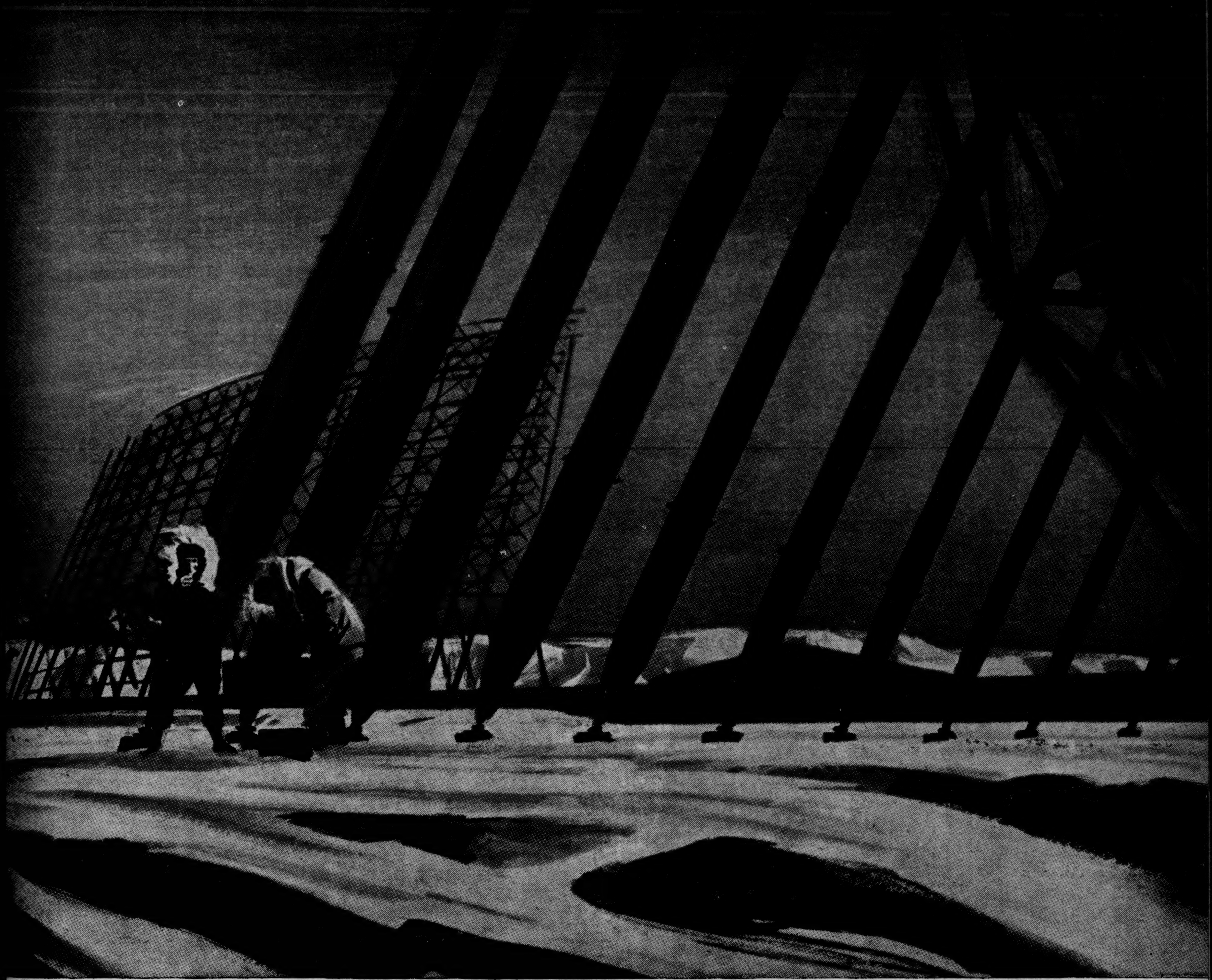
KEEPING BMEWS ON THE AIR

RCA Checkout and Automatic Monitoring Equipment Guards BMEWS Reliability Around the Clock

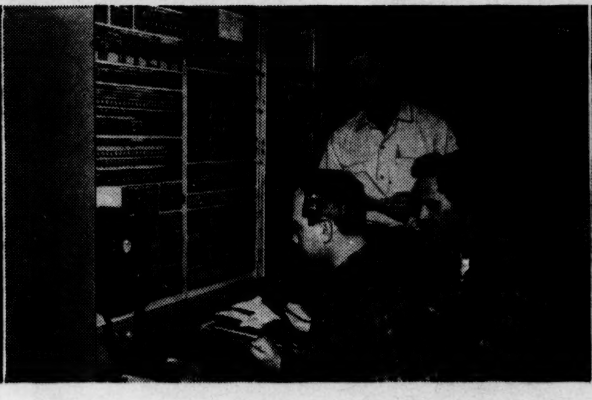
The incredible complexity of the BMEWS network and its vital mission in continental defense demand the ultimate in system reliability. Through unique and highly advanced developments by RCA this standard is being achieved.

The RCA Checkout Equipment installed at BMEWS sites performs a dual function—it generates and inserts realistic simulated target problems for on line exercising of the entire system. These integrated tests are designed to test the BMEWS early warning capability to its fullest extent. Automatic monitoring detects degradation prior to failure and isolates marginal conditions or malfunctions enabling rapid corrective maintenance.

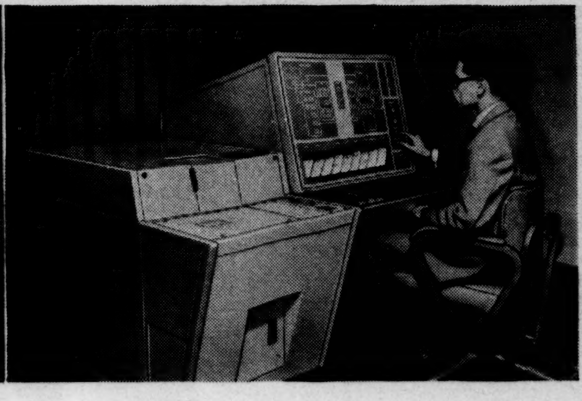
Around-the-clock operation of this RCA equipment enables BMEWS to meet its over-all operability goal with negligible downtime, thus keeping BMEWS on the air!



The Central Automatic Monitoring Console displays the status of the entire site and displays equipment degradation prior to failure.



The Checkout Data Processor generates simulated missile attacks and evaluates the BMEWS response to the simulation.



The Automatic Monitoring Console displays degradation and the location of degraded equipment.

RCA Checkout and Automatic Monitoring (CAM) Equipment has greatly enhanced the reliability of complex ground environment systems. Adaptable for use in systems already completed, and as an integration tool for systems currently being implemented. CAM equipment is available for all complex commercial, military, and government systems. For a description of the RCA Checkout and Automatic Monitoring Equipment, write to: RCA Major Defense Systems, **Defense Electronic Products,** CAM 127-204, Moorestown, New Jersey.

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A MAJOR CAUSE OF FAILURE ELIMINATED BY BUILDING A TRANSISTOR INSIDE ITS OWN SHELL

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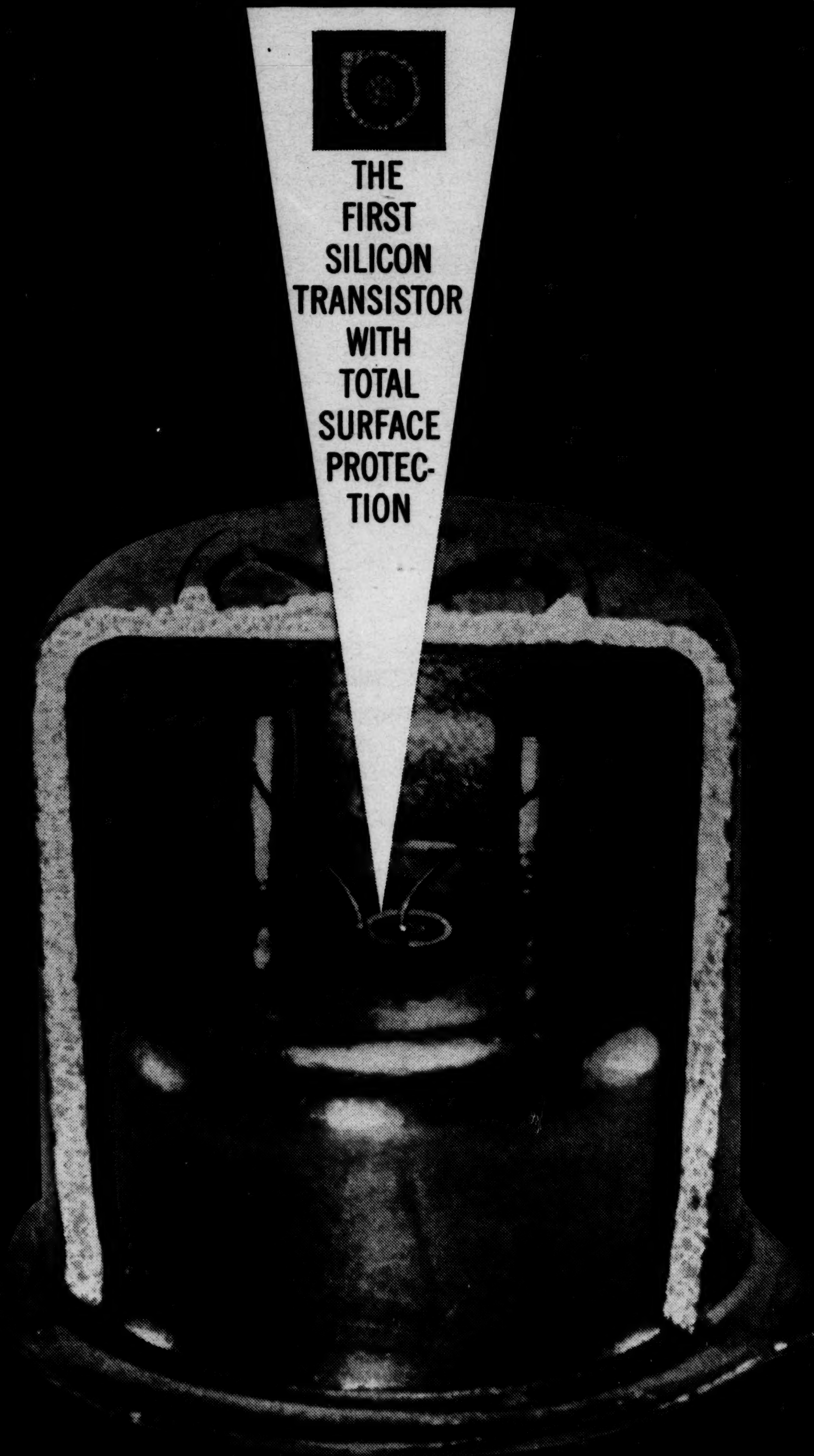


problem because of its size and the uncertainty of the intensity and distribution of micrometeorites. To study the latter problem, useful information is expected to be obtained within the next few months from a micrometeorite experiment, which has been planned for launching into orbit from Wallops Island, Va., using a Chance Vought Scout vehicle, he said.

This experiment is designed to provide continuous micrometeorite population information at altitudes of 200 to 800 mi. above the earth.

Snap 8 Details

Snap 8 will develop 30 electrical kilowatts with one power conversion system and 60 electrical kilowatts with two conversion systems operating in parallel with a single nuclear reactor. In the 60-kw. version, Snap 8 may be carried on a Centaur vehicle to perform unmanned orbiting missions around Mars or Venus. The Centaur boost vehicle can inject about 8,500 lb. into a near-earth orbit. If a spacecraft propelled by a Snap 8 ion engine is launched into an earth orbit by the Centaur vehicle, it can carry a payload of about 3,000 lb. around Mars after a trip time of about one year, Finger estimated, while in comparison, the all-chemical Centaur can orbit only about 200 lb. on a similar mission, although its trip time will be only six months.

Also, the Centaur-Snap 8 electric rocket combination can orbit a payload around Mars equal to that of a much larger and more expensive four-stage Saturn having a takeoff thrust of 1.5 million lb., he pointed out.

Conjectural Schemes

Finger also touched briefly on several advanced propulsion schemes, still in the conjectural stage. These include the solar sail, which derives power from the small but measurable radiation pressure of the sun upon a sail. He noted that the orbit of Echo I was affected "very significantly" by this phenomenon.

A similar approach is the radioisotopic sail, which has an Alpha emitter coating one side of a thin, large area surface.

The recoil energy of the Alpha emission would act to propel the sail.

Another possible scheme he mentioned involves use of exotic fuels such as rare gas ionic compounds, such as argon octa-fluoride, which might produce specific impulses of over 2,000 sec.

Finger said such compounds are presently purely theoretical and probably would be highly unstable, require temperatures of at least 2 million K to produce and, if developed, would require that gases at 25,000K be contained in the rocket chamber.

Project Mercury Stress Data Emphasizes Pilot's Active Role

Langley Field, Va.—Base line data has been obtained on the seven Project Mercury satellite pilots in eight general stress areas, and some stresses have exceeded loads anticipated in the orbital flight mission.

Dr. Robert B. Voas, a psychologist attached to the Space Task Group and one of the scientists who developed the pilot training program, feels the pilot's task is generally underestimated because of the completely automated mission program. Voas said the Mercury pilot cannot be passive, but rather he must be able to perform under unusual stresses and combinations of loads.

Pilots have undergone these stress loads:

- **Accelerations,** a maximum of 18g, with light profiles flown to 16g to simulate aborts. Time above 4g has been limited to about 90 sec. Atlas missions will have 7g launch and 8g re-entry loads. Redstone ballistic flights will have 6g launch and 11g re-entry stresses.
- **Weightless flight,** with an average total experience of 30 min. Pilots are harnessed while flying Keplerian maneuvers in F-100 aircraft, wtih a 60-sec. maximum zero-g experience on each flight. Free-floating weightless experience, in 15-sec. flights, is obtained in C-131 and C-135 aircraft.
- **Reduced pressure** in the full pressure suit to a simulated 65,000-ft. altitude at 5 psi.
- **Heat,** for 90 min. at 105F and 40% humidity, and 85F at 85% humidity. Extended wait for recovery in tropical regions is considered a higher potential stress than the re-entry heating load.
- **Disorientation,** with an average total experience of 30 min. in the Navy's disorientation room at Pensacola.
- **Tumbling experience** on the multiple axis test facility at Lewis Research Center. The seven pilots have received up to 54 cycles per minute of random tumbling to simulate capsule tumbling, and they have established a rough rule that it takes about a second to recover from each cycle-per-minute.
- **Carbon dioxide increases,** to simulate malfunction of the environmental system. Normal 0.03% earth environment was increased to 3% over a four-hour exposure period with no observable effects.
- **Noise and vibration** exposure. Noise will reach a decibel level of 105-110 inside the capsule. The astronauts have experienced a 140-db. level.

Considerable experience is being obtained in the 20-lb. modified Navy Mk. IV full pressure suit to be worn on ballistic and orbital flights and which is worn during most tests.

Standard Mk. IV suit has been reinforced, rigid glove fingers have been curved, and 2.5-lb. boots have been incorporated to replace the much heavier standard flight boots.

Standard suit had a single zipper at the throat, which irritated the pilots' Adam's apples. It was replaced by two off-center zippers, both for Mercury and Navy applications.

Pilot's Active Role

Miniature bio-sensor devices will telemeter pilot temperature, electrocardiogram and respiration. Thermometer will be a probe, and EKG and respiration will be monitored by disk instruments. Because of the few direct measurements, Voas emphasizes the importance of the pilot as an active part of the research and evaluation process.

Medically, the pilot will report on his performance ability to feel, smell, sense and perceive during his weightless flight. He will report on his physiological and psychological processes, on his observations of earth and space, and on non-programed situations to provide flexibility in communications and to backstop operation of the command programmer.

Chimpanzees which will preceed pilots on Mercury flights have a shock-avoidance task to perform on the Redstone mission and a reward task on the orbital flight.

Chimpanzee Tests

Chimps have been at Cape Canaveral several months (AW Dec. 5, p. 32) training for the missions. Coach package for the Redstone ballistic flight will contain a shelf with blue, white and red lights and levers in front of blue and red lights.

Red light will glow steadily, and the chimp must pull the handle in front of this light every 20 sec. to avoid a shock.

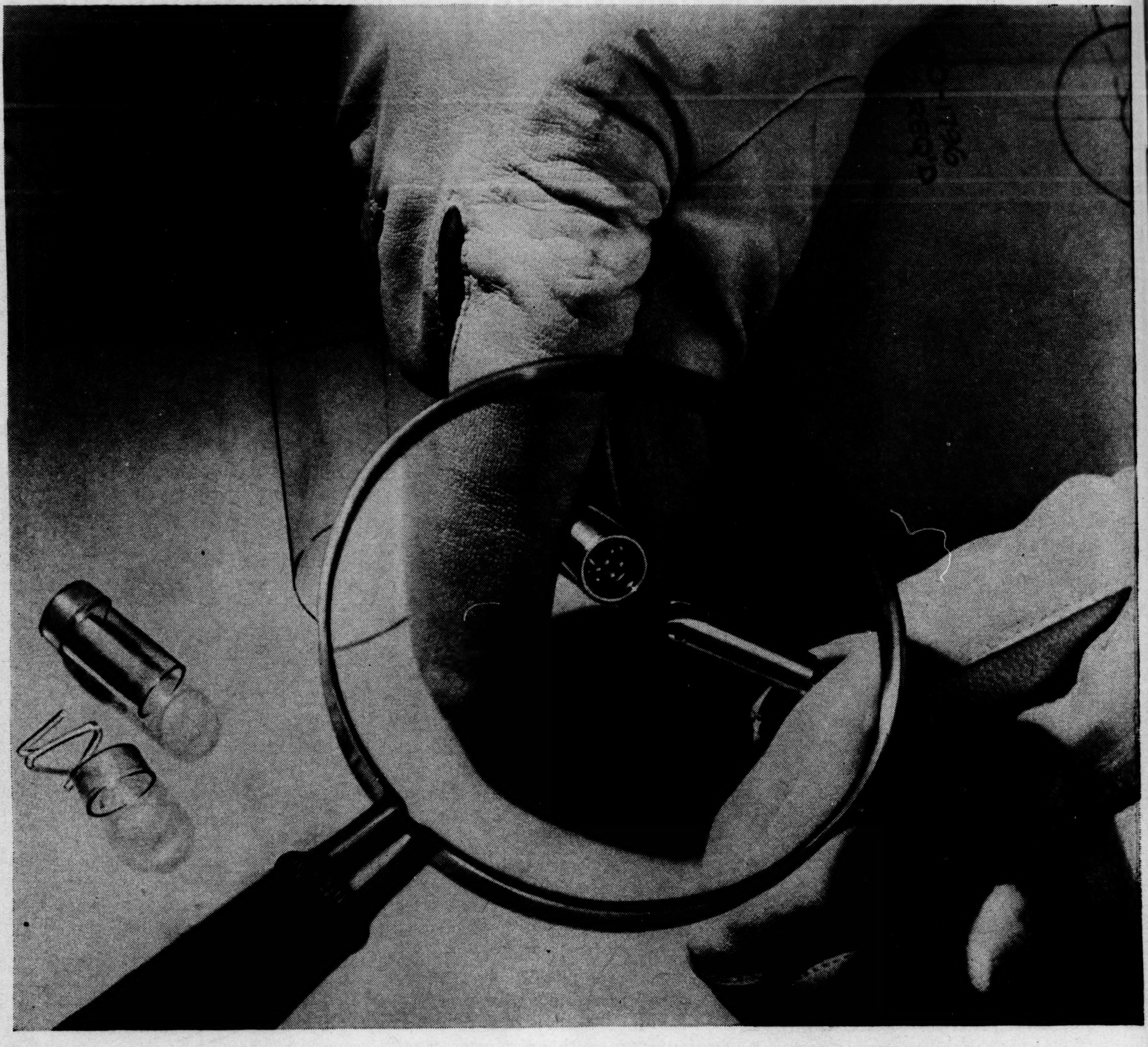
The blue light shines at random, and the chimp must pull its associated lever within five seconds of the time it lights to avoid a shock.

White light blinks on to show correct performance.

In the Atlas-chimp orbital mission, the chimp must pull one of three levers to eliminate the odd symbol in a set of three.

If it performs correctly, the chimp will receive either a drink of water or a banana pill from dispensers next to his head.

NEW DEPARTURES IN MINIATURE



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PROBLEM: Loss of accuracy in torpedo's guidance system due to hang-up of caging arm in gyro assembly.

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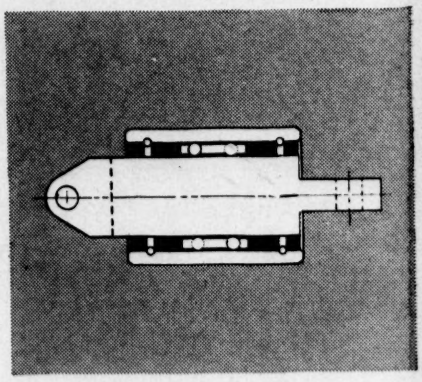
Should you require ball bearing design information, invite the local N/D Sales Engineer to participate in your early design discussions. He represents one of the industry's largest engineering staffs devoted exclusively to the design and development of miniature and instrument ball bearings. Or, write for new Miniature and Instrument Ball Bearing Catalog, Department L.S., New Departure, Division of General Motors Corporation, Bristol, Connecticut.



This special N/D linear motion instrument ball bearing increased guidance reliability of ASTOR torpedo weapon system developed by Westinghouse.

NEW DEPARTURE

MINIATURE AND INSTRUMENT BALL BEARINGS

Project Relay Will Have Year's Orbit Life

Washington—National Aeronautics and Space Administration briefed industry last week on its planned Project Relay, a low-altitude real-time communications satellite and probably forerunner of a commercial communications satellite system capable of relaying television and telegraphy between continents.

The projected, 85-lb. dual purpose satellite (AW Jan. 23, p. 30), which is to have a useful operating life of one year in orbit, is expected to receive and then retransmit wideband communications from eastern United States to western Europe for at least 40-hr. during its first month in orbit.

NASA stresses the research and development nature of the program. Its dual missions are to study the technological problems of transmitting wideband communications by various techniques from a low-orbiting satellite and to conduct radiation effects experiments. The latter are to obtain experimental data on radiation damage and other environmental effects on critical avionic components, such as solar cells. NASA says these experiments are to be correlated with measurements of integrated flux and energy levels of protons and electrons to obtain component lifetime estimates.

The radiation experiments to be conducted with government-furnished instruments are a key part of the program as the satellite is expected to spend a large portion of its 180-min. orbital period in both Van Allen radiation belts.

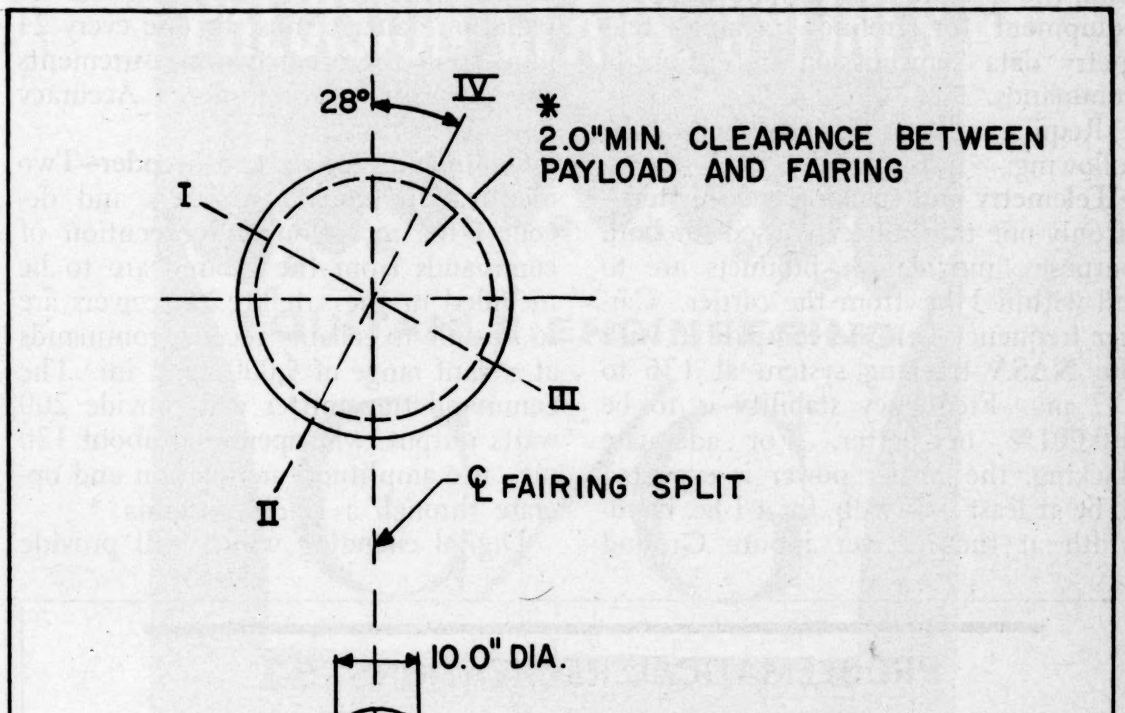
First satellite launch is anticipated sometime after May 1, 1962, from the Atlantic Missile Range unless present NASA plans are accelerated. This date was pegged to the availability of a Delta launching vehicle which NASA hopes will boost the R&D satellite into an elliptical orbit (2,500 to 3,000 naut. mi. apogee, 600 to 1,400 naut. mi. perigee—inclined 30 to 55 deg.).

For relaying wideband communications, current thinking envisions use of two ground stations with 85-ft., 50% efficient parabolic antennas complete with auto-track and programed tracking capabilities at each station. Low-noise ground receivers are to have equivalent temperatures not exceeding 150 deg. Kelvin. With only these items fixed beforehand, bidders are required to outline complete ground equipment needed with the system.

Industry proposals for Project Relay are due no later than the close of the business day on Mar. 6 at NASA's Goddard Space Flight Center.

According to preliminary specifications issued to potential bidders by NASA prior to last week's meeting, the contractor will have to satisfy these payload parameters:

- **Bandwidth and modulation**—Equivalent video bandwidth of 3 mc. (at 6 db. points) must be obtained by whatever bandwidth and modulation technique is selected. Attenuation at 2 mc. is not to exceed 2 db.
- **Signal-to-noise ratio**—Minimum permitted s/n ratio where conventional TV transmission is involved must be 25 db. with 35 to 45 db. regarded as more desirable.
- **Standards conversion**—Ground system must have the capability of converting from U. S. to European standards and reverse where TV transmission is involved. One standards converter capable of converting either way will be located at the U. S. site. Conversion is not to be made in the satellite.
- **Aural signal**—An 8-kc. effective bandwidth is to be received at the ground. Signal-to-noise ratio, NASA specifies, is to be such that the noise level in the 40 to 8,000-cps. band will be at least 45 db. below a level representing 100%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IV
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2.0" MIN. CLEARANCE BETWEEN PAYLOAD AND FAIRING
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DELTA VEHICLE LOW-DRAG FAIRING
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1.0 MIN. CLEARANCE BETWEEN PAYLOAD AND SEPARATION PLANE
16.25"
29.0" DIA.
PAYLOAD SEPARATION PLANE
*
INFRINGEMENT ON MIN. CLEARANCE SHOWN MUST BE COORDINATED WITH AND APPROVED BY N.A.S.A./G.S.F.C.

PAYLOAD envelope of proposed National Aeronautics and Space Administration active communications satellite appears within fairing atop third stage vehicle. The 85-lb. satellite is to be launched into an elliptical orbit inclined 30 to 55 deg. from the earth's equator sometime after early spring, 1962. Contemplated apogee will be 2,500 to 3,000 naut. mi., perigee 600 to 1,400 naut. mi. Proposals for the satellite, called Project Relay, are due at Goddard Space Flight Center Mar. 6.

modulation of the sound carrier. Receiver-transmitter distortion contribution is not to exceed 5%.

- **Frequencies**—Signals transmitted from the ground to the satellite will be in the 400 to 500-mc. band while those from space to ground will be in the 2,200 to 2,300-mc. band.

When the transmitter/receiver is not engaged in relaying video signals it is to be employed for transmission of multichannel telegraphy and other data. The transmitter will be activated through a single tone channel turned on by command from the ground. This channel is to be paralleled with a 120-mc. command system channel.

In addition to the communications equipment necessary for the relay function, the satellite is to contain sufficient equipment for ground tracking, telemetry data transmission, reception of commands.

Requirements in this area include the following:

- **Telemetry and tracking transmitters**—If only one transmitter is used for both purposes, modulation products are to fall within 1 kc. from the carrier. Carrier frequency is to be compatible with the NASA tracking system at 136 to 137 mc. Frequency stability is to be ±0.001% or better. For adequate tracking, the carrier power is expected to be at least −120 db. for a 1-kc. bandwidth at the receiver input. Ground tracking antenna gain can be estimated at 15 db.
- **Telemetry receiver**—Receiver anticipated for use in Project Relay has antenna gain of 19 db., tuning range of 136 to 137 mc. in 1-kc. steps, available bandwidths of 1 mc., 300 kc., 100 kc., 30 kc., and 10 kc., noise figure of 4 db., manual, normal and delayed AGC modes, AM, PM and FM detection.
- **Telemetry encoder**—Means of encoding telemetry data into PCM form for modulation of the telemetry transmitter must also be included. Provision must be made to sample vehicle parameters as well as to send radiation experiments data. Radiation experiments require 65 data channels (32 for the radiation monitor, 24 for radiation damage and nine for solar aspect). Sampling rate for radiation damage must be one every 24 min. while the other two measurements are sampled once a minute. Accuracy must be within 5%.
- **Command receiver and decoder**—Two identical, redundant receivers and decoders for reception and execution of commands from the ground are to be included in the satellite. Receivers are to be able to reliably receive commands at a slant range of 5,000 naut. mi. The command transmitter will provide 200 watts output, will operate at about 120 mc., use amplitude modulation and operate through a 12-db. antenna.

Digital encoding which will provide reliable operation with small signal-to-noise ratios will be employed. Satellite decoder power consumption will be about 70 milliwatts at −6 volts; negligible power is required from a $\frac{1}{2}$-volt source.

The decoder can be built on two disks, NASA says, each about 5 in. in diameter and $\frac{3}{4}$-in. high. Command capability would then include telemetry transmitter turn on and off, telemetry modulation turn on and off, wideband transmitter turn on and off.

- **Antennas**—Necessary antennas for tracking and telemetry transmitters and command receivers must be provided, and the receiving antennas must be compatible with the TV antenna system. Antenna radiation patterns are to be isotropic and symmetrical with respect to the satellite's spin axis. Polarization will be circular, deep nulls confined to the vicinity of the spin axis.

Radiation experiments which NASA plans to include in the Project Relay shots will impose additional restraints on the payload design. These are:

- **Radiation monitor**—Power required, 2.5 watts; weight, 12 lb.; volume, 39 cu. in.; external satellite area required for its sensors, 1 sq. in.
- **Radiation effects**—Power required, 3 watts; weight, 6 lb.; volume, 48 cu. in.; external satellite area required for its sensors, 12.5 sq. in.
- **Solar aspect indicator**—Power required, 1 watt; weight, 1 lb.; volume, 3 cu. in.; external satellite area required for its sensors, 3 sq. in.

Solar cells, rechargeable batteries and associated devices and circuitry will comprise the power supply. The contractor must base his design on a 35-min. assumed eclipse period for each orbit. Actually, NASA estimates eclipse periods of 25 to 55-min. duration during the first 30 days of orbit, increasing thereafter to a maximum of 70 min.

Complete power supply will be expected to operate reliably within tolerances set by the potential contractor for 30 days in a realistically synthesized space environment with a duty cycle which simulates orbital operation with a reliability of 0.93 at 90% confidence level. Enough measurements are to be made at sufficient intervals so that power supply performance can be evaluated from telemetered data.

The power supply will also contain a manual on-off device accessible through normal fairing access ports for use during final launch preparation. Another device, such as a timer, will be included to turn the power supply off (without command) after it is in orbit for a year.

Other features of the power supply are to include a minimum of 1,000 constant charge-discharge cycles for each battery, protection against radiation, and means of assuring availability

PROBLEMATICAL RECREATIONS 51

Which is greater e^{π} or π^{e}? —*Contributed*

Photos, specs, application information, and V-scan circuitry, both parallel and serial readout, are included in our new Shaft Encoder Brochure. Write for it at Litton Systems, Inc., 5500 Canoga Avenue, Woodland Hills, California.

ANSWER TO LAST WEEK'S PROBLEM: Let the number in a row equal x. Let the number of rows equal y. Then $xy = 600$. $(x - 5)(y + 6) = 600$. Hence the simultaneous solution of these two equations yields $x = 25$.

LITTON INDUSTRIES
Beverly Hills, California

of the solar array output in the event of a single failure somewhere in the system.

A temperature control system carried aboard the satellite will maintain average temperature of the satellite equipment mounting surfaces between 40 and 70F during orbits. Local mounting surface temperatures are to be held between 30 and 120F. From launch until payload separation from the boost vehicle these average temperatures are to be held between 50 and 125 deg. and 30 and 150 deg. respectively. The temperature control system is to be so designed that internal temperatures are independent of changes in eclipse periods or variations in orbital altitudes and is to be relatively insensitive to changes in optical properties of the outer satellite surface.

The satellite itself is to weigh no more than 85 lb. including the radiation equipment and all structure forward of the satellite booster but not including the firing. The satellite envelope, as shown in an accompanying drawing, is 50¼ in. in length, has base diameter of 29 in. and top diameter of 10 in. Principal axes of inertia are to be almost perpendicular and parallel to the payload's spin axis, which is identical to the payload's center line. Distance between the satellite's spin axis and its center of gravity is not to exceed 0.02 in.

Satellite Inventory

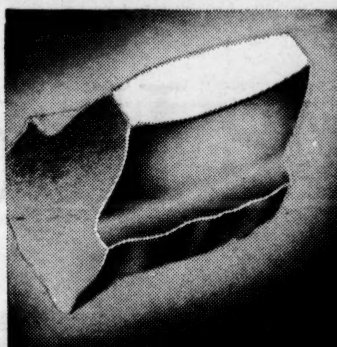
Contractor will be expected to supply:

- **One prototype satellite** for qualification tests.
- **Two satellites for flight.**
- **One satellite as a spare.**
- **One structural model** with dummy electronics for structural tests.

Transmission times (periods during which the satellite is in sight of both ground stations at an elevation angle of at least 3 deg. from each station) will vary from approximately 10 to 35 min. These occur on three or four consecutive passes a day for at least the first 30 days, NASA estimates.

Satellite equipment is expected to operate a total of about 16 hr. during checkout in the hangar at the Atlantic Missile Range and on the launch stand before liftoff. Another 22 min. of operation will be logged by airborne tracking and telemetry equipment during time from liftoff of the booster to injection of the satellite into its earth orbit. Once in the orbital phase the command receiver and tracking systems will operate continuously throughout the one-year lifetime of the satellite. The wideband transmitter/receiver system will operate at least 40 hr. during the first 30 days of the orbit.

Because of the severe environments the payload and its gear will experi-



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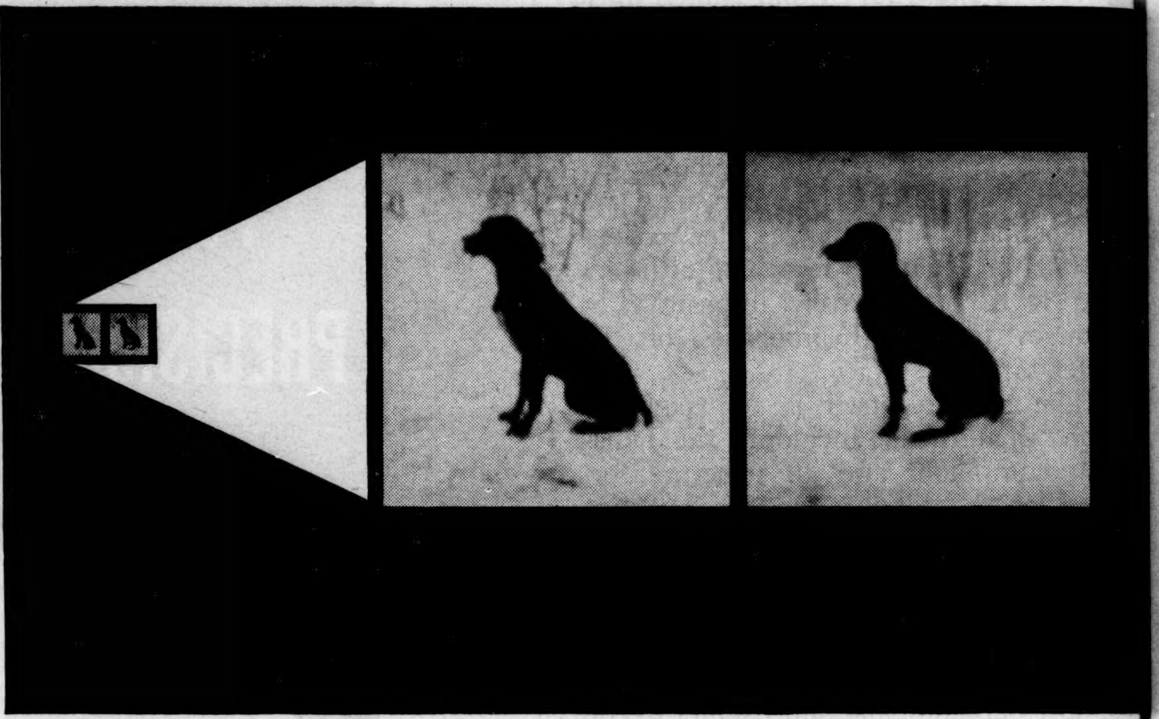
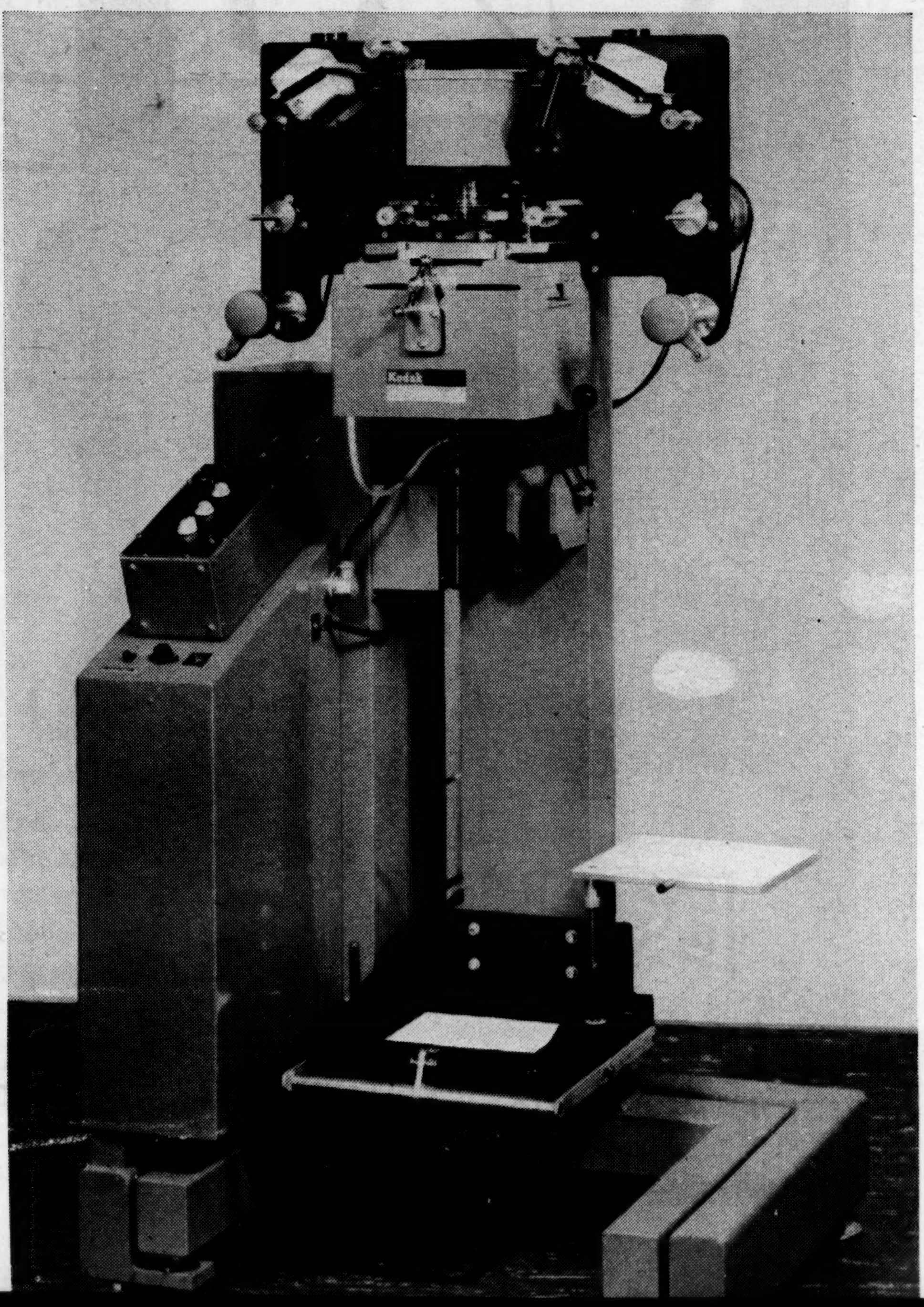
Is this a picture of two inanimate objects? *"No."*
Is this a picture of two animals? *"Yes."*
Are they large animals? *"No."*
Two-legged animals? *"No."*
Are they feline? *"No."*
Dogs? *"Yes."*
Longhair dogs? *"No."*
Is one a German Shorthair dog? *"Yes."*
Is the other? *"No."*

And now a message from the sponsor:





The uninitiated have now been initiated in didactically rudimentary fashion in the spirit with which the piece of equipment pictured at the left digs out, *bit by bit,* information of real consequence provided by an ambitious photographic system.

The item was custom-built by the Kodak *force in being,* which modestly calls it a 20X precision enlarger. The item is not stocked for sale.

All this enlarger does is: 1) remove dust and static charges from the film, 2) project the film while it is submerged in a liquid of matching refractive index, 3) insulate the film from vibration, 4) resolve 200 lines per millimeter to the edge of the picture and more than 400 lines in the center.

This is not a "breakthrough" in enlargers as we understand the term. But it is, we hope, the best enlarger in the world.

It is as good as it is for the simple and undramatic reason that a new method of optical analysis now provides a clearer insight into these matters. We now know that the term "resolving power" doesn't describe fully enough the ability of an element in a photographic system to handle fine detail. The perform-

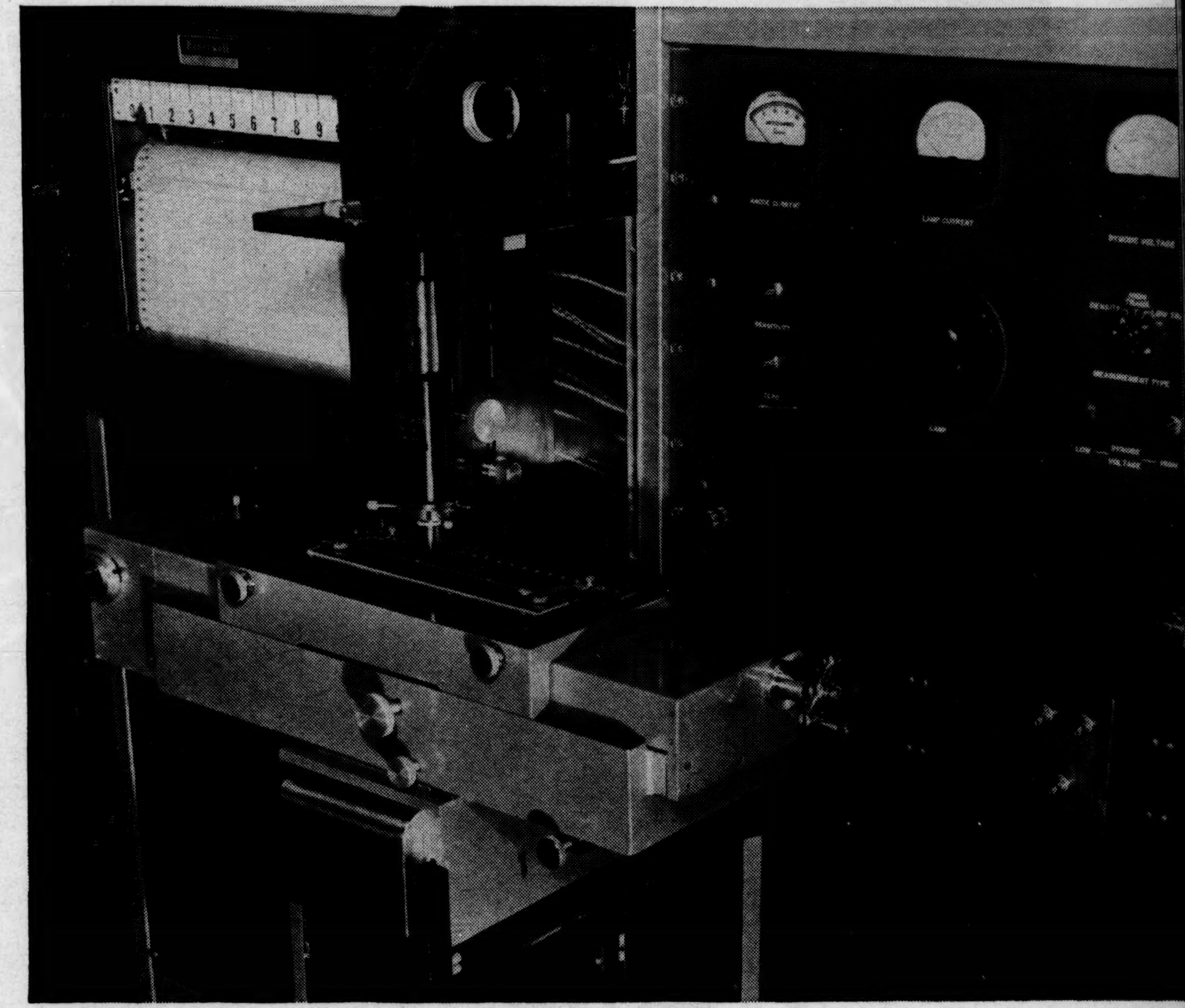
photographic systems

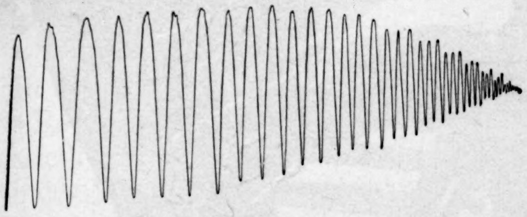
ance of the enlarger shows the practical worth of some theories we have had wherein the term "resolving power" is replaced by a more revealing concept from the electrical engineer's vocabulary – "sine-wave frequency response."

Can you imagine treating a photographic lens or a photographic emulsion, or a combination of the two, as though it were an a-c system and developing equations for its sine-wave frequency response? That's exactly what we are doing.

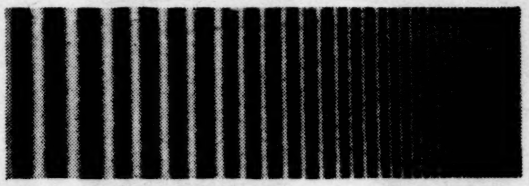
At right is pictured one of the practical tools we are doing it with.

It is a microdensitometer we built to measure details in a photographic image down to 0.00005 inch.

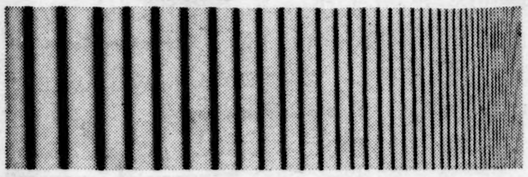




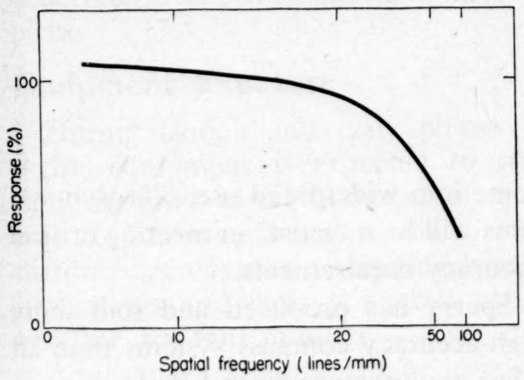
This is the microdensitometer trace



of this photographic reproduction



of this sine-wave test object.



And here we have plotted the relative amplitude of the above photographic reproduction as a function of spatial frequency. This is the "sine-wave frequency response" of the photographic system.

Could it be we've hit on a common denominator, a common language for photographic-emulsion men, lens men, and electronics men?

Is it possible to apply the same Kodak-engendered theoretical models and practical tools to the optical, mechanical, and photographic-emulsion elements of a photographic system, *plus the electrical elements, if any?*

And if we do, does it become possible to predict the ability of the total system to reproduce detail in terms of signal-to-noise ratio in the final big picture?

Yes, on all three counts. We submit the work of our 20X precision enlarger as exhibit "A."

Before you call us in to build a total photographic system based on these principles, you might wish to write for a review paper by one of our men whom we have kept busy for many years combing out the principles. Its title: "Methods of Appraising Photographic Systems." It is not so simple as this advertisement.

On the other hand, we've already read the paper, so if you'd like to get started . . . *shall we meet and talk about the connection between our capabilities and your problems?*

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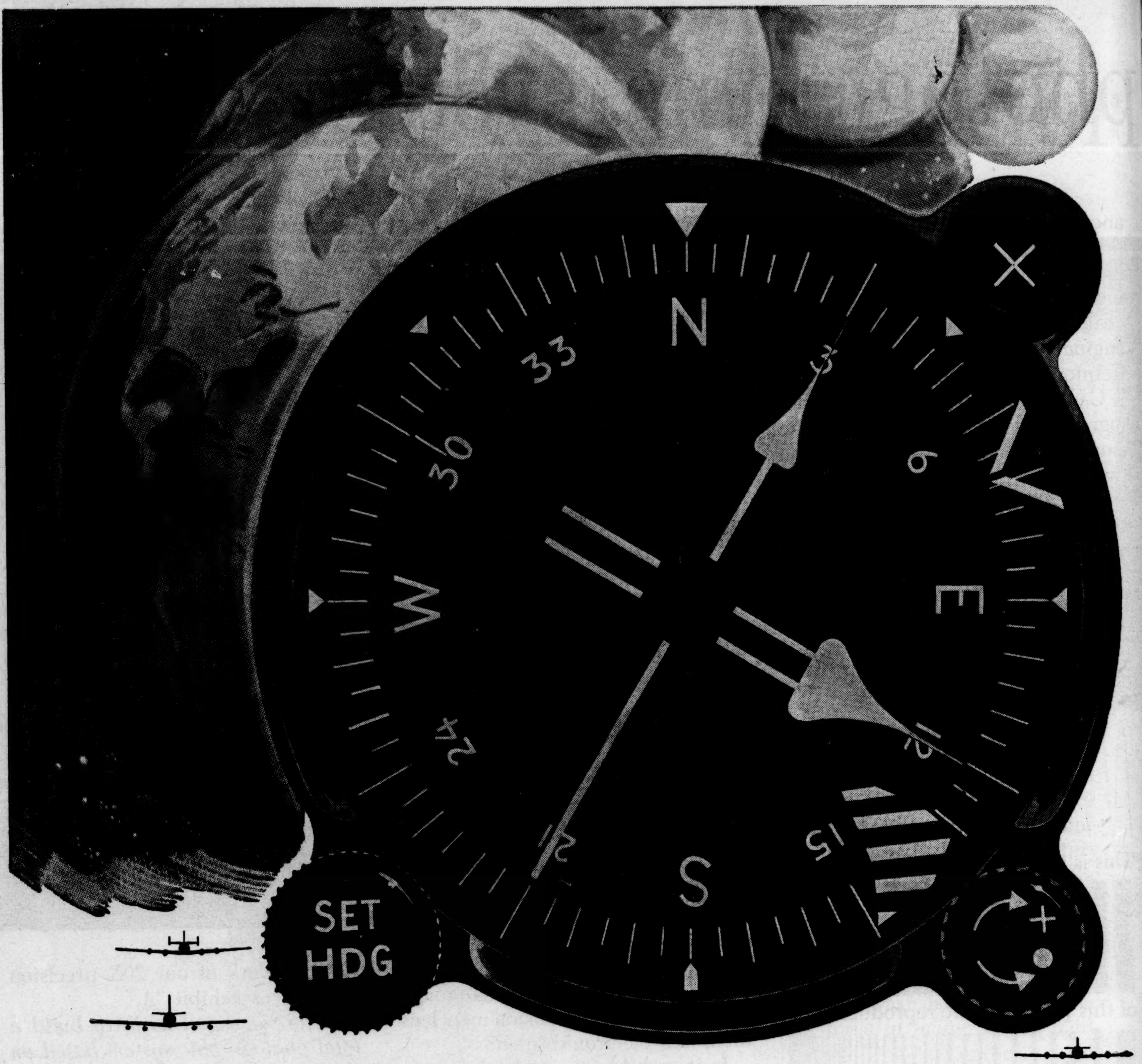
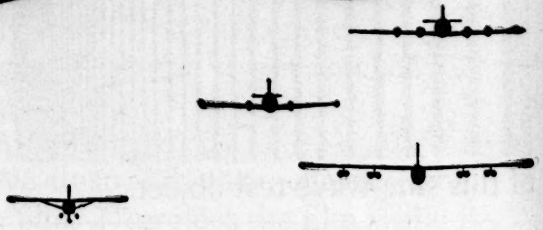
For the above-mentioned paper and the new booklet, *Kodak/ a Force in Being,* that summarizes our work in coordinating these fields, write Government Contracts Department,

EASTMAN KODAK COMPANY, *Apparatus and Optical Division, Rochester 4, N. Y.*





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The Gyrosyn combines the functions of both a directional gyro and a magnetic compass. The differences in the particular models–which include the C-2, C-4, C-8, C-9, C-10 and C-11–relate to size, weight, performance and cost consistent with the application.

The C-2 is the lightest and most compact system available, weighing only 8¼ pounds. The transistorized C-11 incorporates Rotorace® suspension to hold random drift within ± 0.5 degrees an hour in "free-gyro" operation on transpolar routes. As Doppler navigators come into widespread use, Gyrosyn systems will be a "must" in meeting critical accuracy requirements.

Sperry has produced and sold more high-accuracy compass systems than all other manufacturers combined.

SPERRY

SPERRY PHOENIX COMPANY, *DIVISION OF SPERRY RAND CORPORATION, PHOENIX, ARIZONA* ence before launch and during its one year active lifetime, NASA requires that the equipment must operate after experiencing the following prelaunch conditions:

- **Ambient temperature**—Temperatures to which the equipment might be exposed range from 65F (unrestricted air transport and −35F (restricted air transport) to 125F (sheltered ground conditions) and 160F (unsheltered ground conditions).
- **Humidity**—Relative humidity up to 100% with resulting condensation as water or frost.
- **Shock**—Pivot drops of 4 in.
- **Vibration**—Vibration of 3.5g rms. at 59 to 50 cps. and 1.5g rms. at 50 to 300 cps.
- **Altitude**—Sea level to 50,000 ft.

Orbit Operations

For operation during orbit, the equipment must meet specifications after being subjected to these conditions:

- **Temperature**—External surfaces of the satellite will be heated by a combination of solar irradiation of the sunlit surfaces of the vehicle, radiation emitted from the earth, and sunlight reflected from the earth.
- **Vacuum**—Space vacuum of less than 10 to the $-^{8}$ mm. of mercury.
- **Radiation intensity**—Major portion of satellite period of rotation will be in the inner Van Allen zone of trapped radiation with a smaller portion in the outer zone. Estimated average radiation dosages which are to be encountered by the satellite are: protons, average intensity—2 x 10^{4} cm. square sec.; integrated flux per revolution, 2 x 10^{8} protons/cm. squared; integrated flux per month, 4.8 x 10^{10} protons/cm. squared, and electrons (greater than 600 KEV), average intensity—10^{8} cm. squared sec.; integrated flux per month, 2.4 x 10^{14} electrons/cm. squared; integrated flux per month, 2.4 x 10^{14} electrons/cm. squared. Micrometeoroids are not expected to penetrate the satellite during the orbital phase.

Equipment Exposure

During launch and early phases of flight, equipment is expected to continue to meet specifications after exposure to extreme vibrations, thermal radiation, aerodynamic heating, solar irradiations and flash temperatures up to 900F for four minutes.

Additional restraints will be imposed on satellite design by conditions at payload injection into orbit and separation from third stage booster. These are a third-stage spin rate of 150 rpm. ±10% and location of the payload spin axis in the plane of the orbit. The satellite's spin axis may deviate from this position by 2 deg. due to tipoff errors at separation.

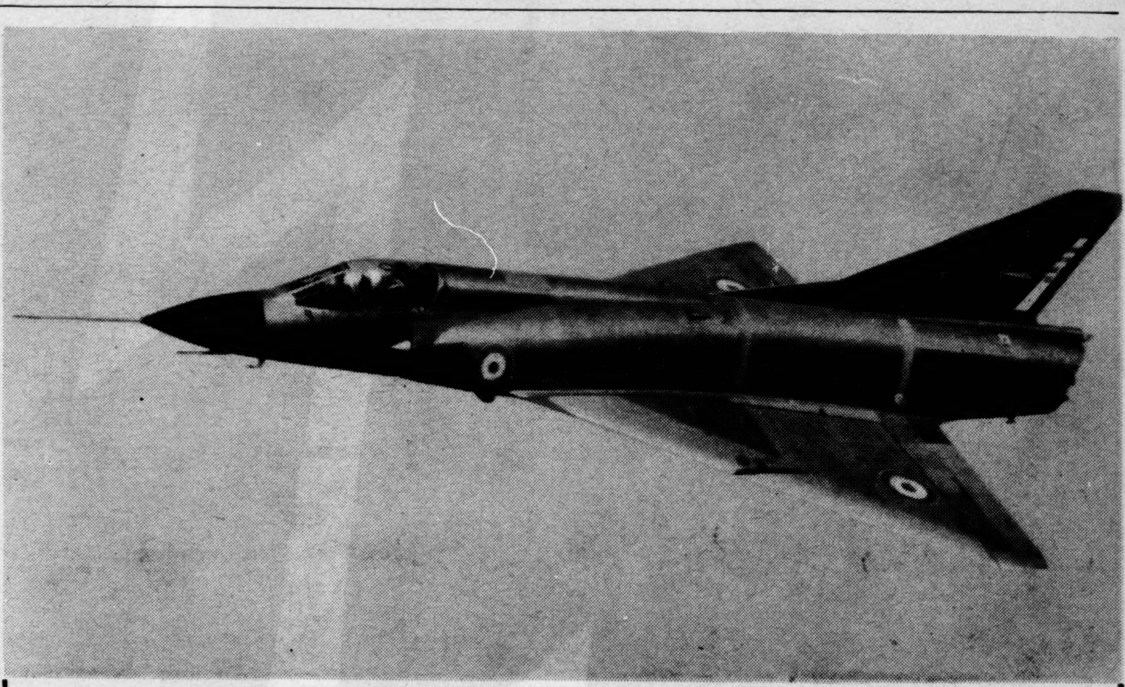
PRODUCTION BRIEFING

Westinghouse Electric Corp., Baltimore, Md., will continue production of the air-to-air missile control system for the McDonnell F4H-1 under an $8.3-million contract. The contract is the third production order for the F4H-1 radar.

United Aircraft Corp.'s Norden Division, Norwalk, Conn., will produce advance search radar and terrain clearance systems for the Grumman A2F-1, Navy attack aircraft, under a $2.6-million Grumman contract. The integrated display system, employing two scopes, provides a visual representation of the ground and air below and in front of the aircraft in all-weather conditions.

Flexible Tubing Corp. of Guilford, Conn., has been awarded a $110,000 U. S. Navy contract for pneumatic jet engine starter ducts. The starter ducts, which are made of silicone rubber with a dacron sleeving and a rubber and dacron outer scuff bumper, will be produced in the company's main plant at Guilford.

Lear, Inc., has received contracts amounting to $2,409,000 for the firm's MC-1 automatic flight control system.



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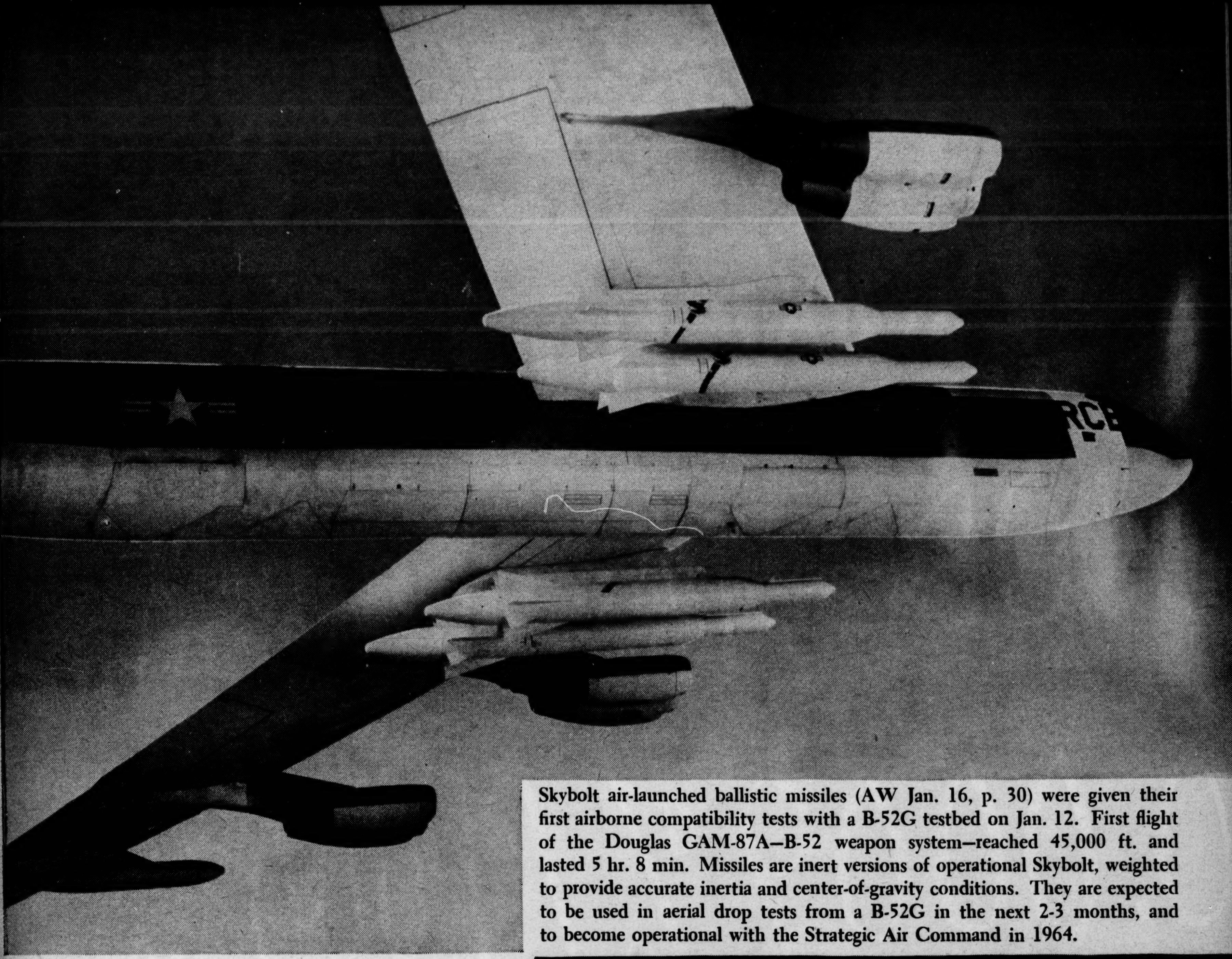
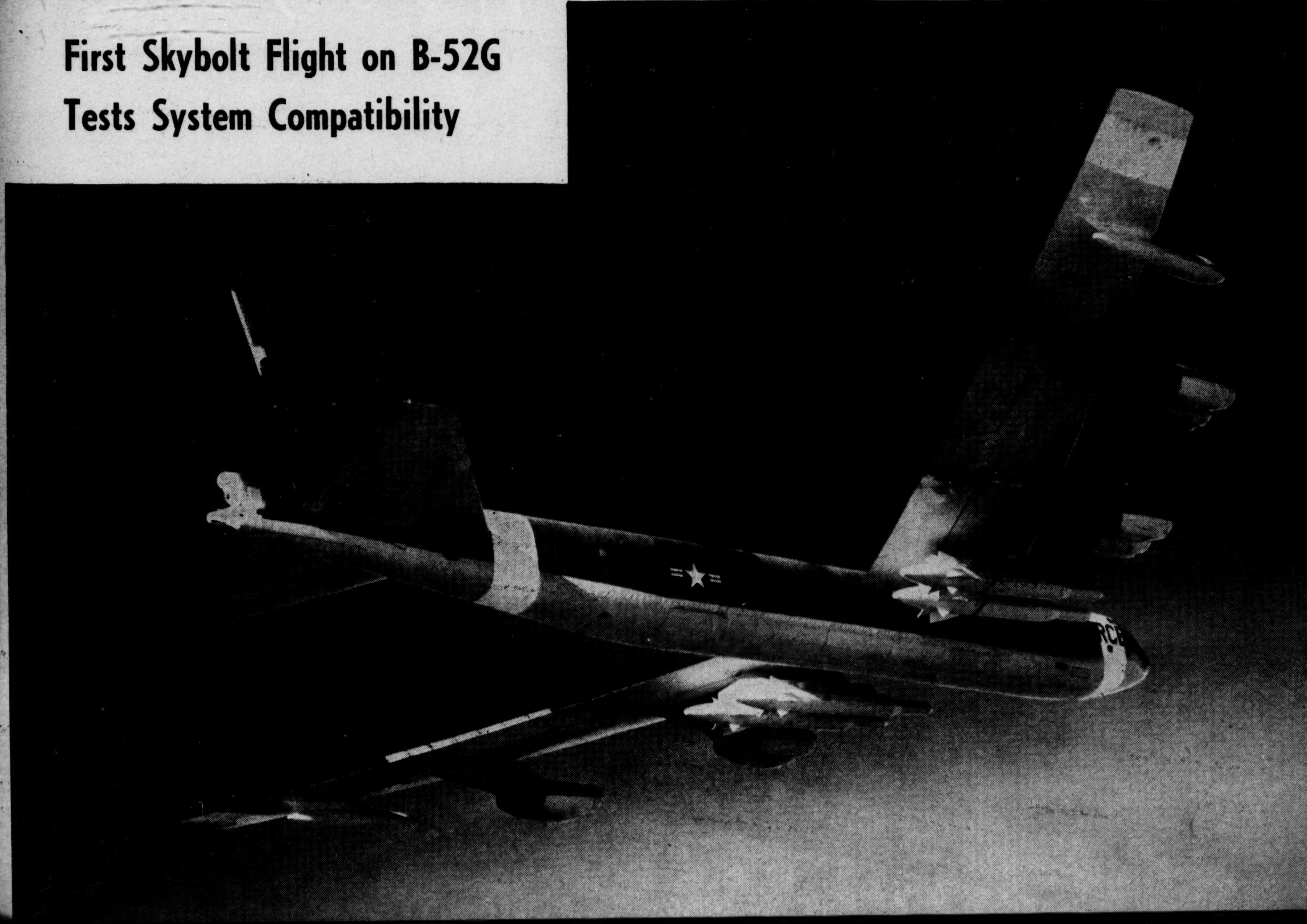
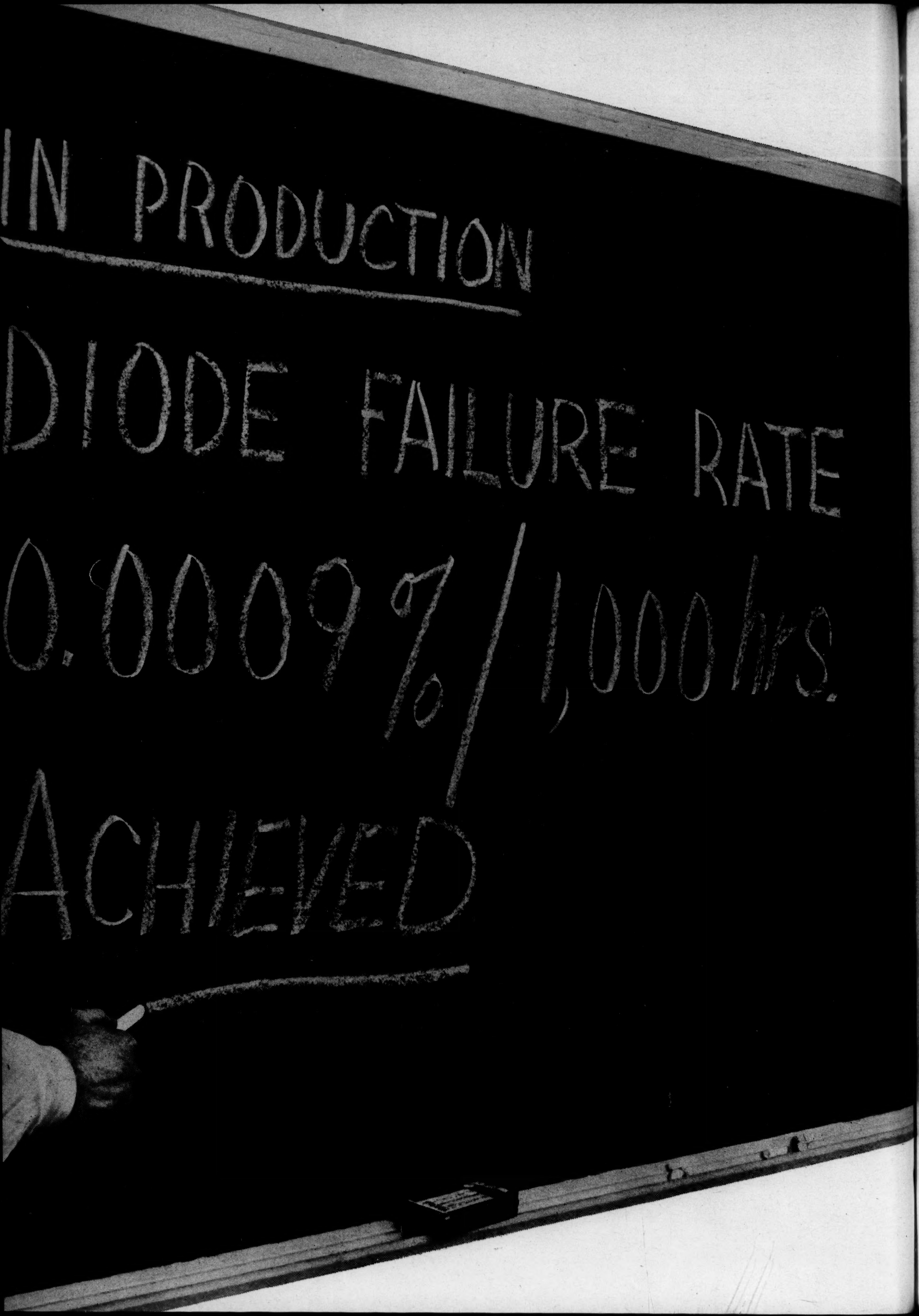
Electromechanical systems by **Autonetics** *Division of North American Aviation*



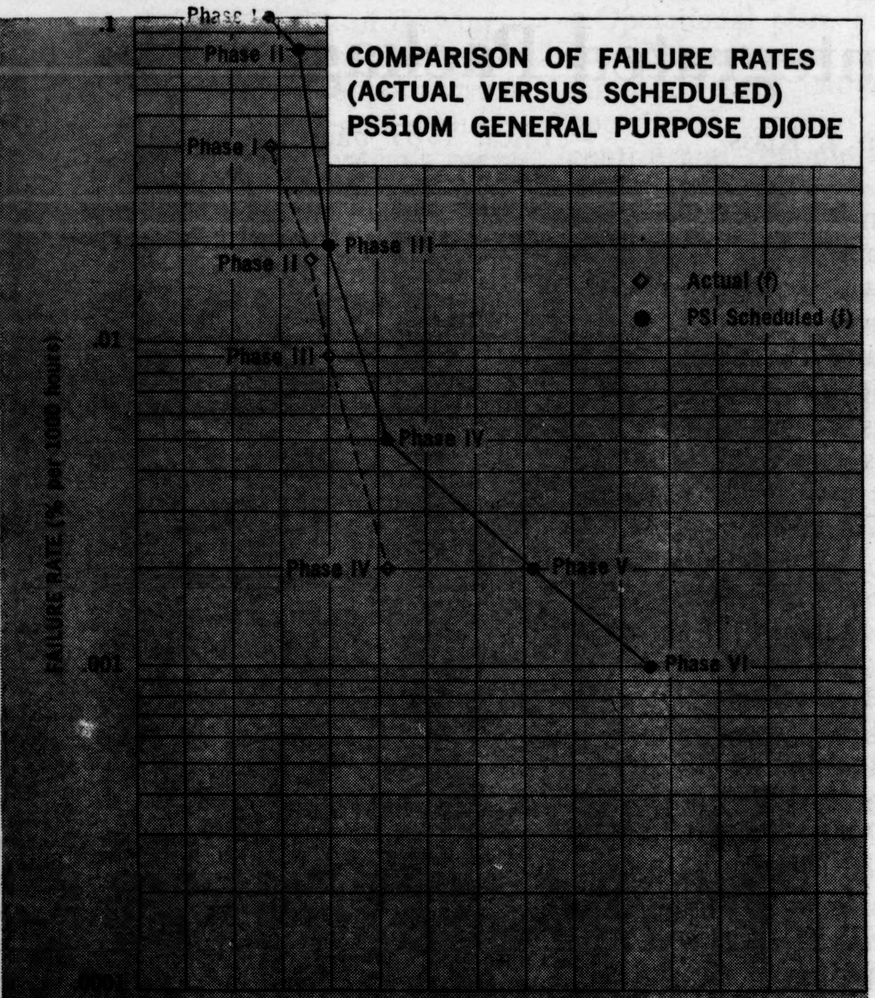
Skybolt air-launched ballistic missiles (AW Jan. 16, p. 30) were given their first airborne compatibility tests with a B-52G testbed on Jan. 12. First flight of the Douglas GAM-87A–B-52 weapon system–reached 45,000 ft. and lasted 5 hr. 8 min. Missiles are inert versions of operational Skybolt, weighted to provide accurate inertia and center-of-gravity conditions. They are expected to be used in aerial drop tests from a B-52G in the next 2-3 months, and to become operational with the Strategic Air Command in 1964.

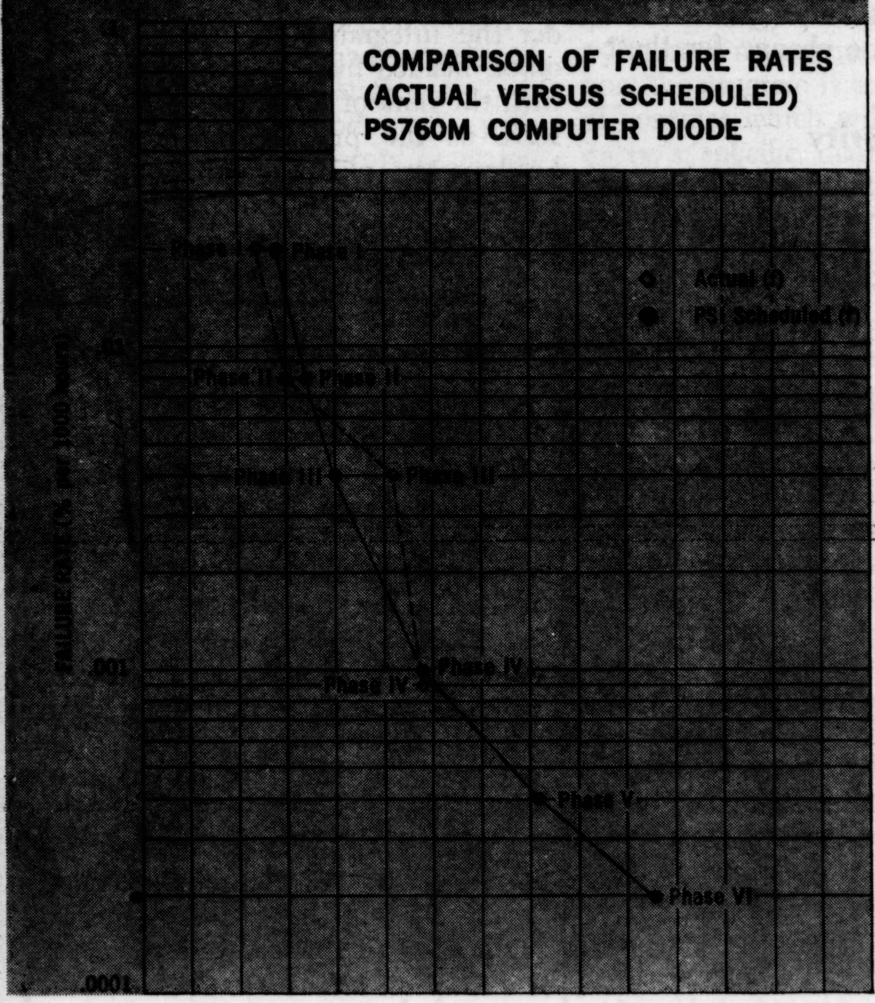
First Skybolt Flight on B-52G Tests System Compatibility




IN PRODUCTION
DIODE FAILURE RATE
0.0009%/1,000hrs.
ACHIEVED

RELIABILITY...PROVED


COMPARISON OF FAILURE RATES
(ACTUAL VERSUS SCHEDULED)
PS510M GENERAL PURPOSE DIODE


COMPARISON OF FAILURE RATES
(ACTUAL VERSUS SCHEDULED)
PS760M COMPUTER DIODE

PACIFIC SEMICONDUCTORS, INC., tests indicate failure rate of .0009% per 1,000 hours ACHIEVED for silicon computer diodes... .002% per 1,000 hours ACHIEVED for silicon general purpose diodes

PSI—qualified supplier of all silicon computer and general purpose diodes for the "Minuteman" ICBM guidance system—has undertaken a production and evaluation program designed to furnish "Minuteman" with ultra-high-reliability diodes. The program is being supported by the Air Force Ballistic Missile Division through the Autonetics Division of North American Aviation.

The ultimate reliability objective is a maximum failure rate of .0002% per 1,000 hours for silicon computer diodes, and .001% per 1,000 hours for silicon general purpose diodes—levels heretofore unattainable in the semiconductor industry. To achieve and prove this objective, more than 250,000 silicon diodes are being used to generate in excess of a billion diode hours of test information.

Results to date indicate that PSI is currently supplying "Minuteman" computer diodes with an indicated failure rate of .0009% per 1,000 hours, and general purpose diodes with an indicated failure rate of .002% per 1,000 hours.

Because of the huge quantity of high reliability diodes required in the "Minuteman" program, PSI has been able to make thousands of diode measurements and use these data to control processes. Since the same controls are applied to *all* PSI manufacturing processes — and *not just to a limited and specially isolated line*—PSI is able to supply high-reliability silicon diodes in large quantities and on a regular basis.

If you are associated with a program requiring ultra-high reliability semiconductor devices, you are invited to take advantage of the vast and growing fund of information and large volume production capacity available only at PSI. For full details, write to Richard A. Campbell, Executive Vice President, Pacific Semiconductors, Inc., 14520 Aviation Blvd., Lawndale, California (Los Angeles County).

PSI

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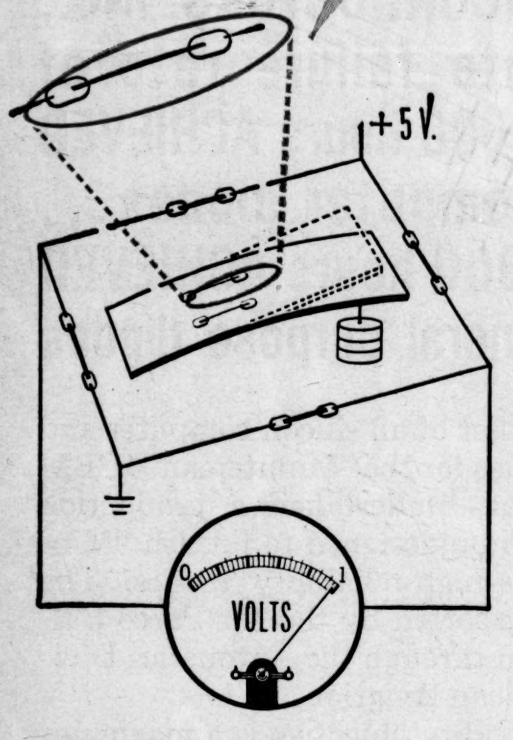

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USAF to Manage Weapon Systems Under Integrated Package Plan

By Philip J. Klass

Washington—A new integrated package plan of programing, funding and management soon will be applied to 11 current Air Force weapon and support system programs, and the plan is expected to be used on most future weapon/support system developments.

Current programs which will be converted to the new management plan include: F-105, B-70, Dyna-Soar, Skybolt, Atlas, Titan, Minuteman, Samos and Midas satellites, the Strategic Air Command Control System (465-L) and the Air Weapons Control System (412-L). The Air Research and Development Command holds executive management responsibility for all of these programs except the F-105, which is directed by the Air Materiel Command.

The new integrated package concept, provided for in the recently issued Air Force regulation AFT 375-1, is an outgrowth of techniques pioneered in USAF's ballistic missile program. Thus it will represent little change for these weapon systems.

Additional Authority

Under the integrated package concept, the System Program Office (SPO), which replaces the old Weapon System Project Office (WSPO), gains additional authority and responsibility. The SPO, and its System Program Director, will be responsible for programing, buying and funding elements of the weapon system which formerly were handled outside the authority of the WSPO, or were furnished as standard items or services by another command. Examples are such things as aircraft engines, ground support equipment and personnel training (AW Sept. 26, p. 31).

Each of the weapon/support systems operating under the new integrated package plan will be allotted enough money to permit its System Program Office to procure everything required to bring the system to full operational status.

Existing weapon/support systems which have not been designated for integrated package management, primarily because they are too far advanced, are to attempt to apply the principles to the maximum degree practicable.

The new plan will be introduced on an evolutionary basis and is expected to be in effect by late spring, when the Air Force submits its first estimates for the Fiscal 1963 budget and its plans for spending the Fiscal 1962 budget.

The System Program Director, expected to have the rank of colonel or brigadier general, will have the direct authority to reschedule programed events or actions, providing a change does not alter previous schedules by more than 90 days. He also will have authority to shift funds within the program to achieve better balance, and to make tradeoffs in performance parameters, providing they do not alter system performance sufficiently to cause it to fall outside limits established by the original Specific Operational Requirements. This would include such factors as minimum range, and maximum range.

SPO Counterpart

A counterpart to the SPO, known as the System Staff Office, will be formed at USAF Headquarters for every weapon/support system program, whether or not it is being handled under the integrated package plan. The office, headed by a System Staff Officer with the rank of lieutenant colonel, will serve as the primary focal point for headquarters planning, programing, reporting and staff action. The System Program Office in the field, however,

Management Study Group

Washington—Air Force's new weapon/support system management concepts are the product of a nine-man Weapon Systems Management Study Group, headed by Gen. Samuel E. Anderson, commander of the Air Materiel Command, and a 12-man support group headed by Brig. Gen. Melvin F. McNickle. The study group, or Anderson Committee as it was known, was formed in the summer of 1959 and submitted its recommendations the following spring. Other members included: Lt. Gen. Dean C. Strother, deputy chief of staff for operations; Lt. Gen. Roscoe C. Wilson, deputy chief of staff for development; Lt. Gen. T. H. Landon, deputy chief of staff for personnel; Lt. Gen. W. D. Eckert, USAF comptroller; Lt. Gen. B. A. Schriever, commander Air Research & Development Command; Lt. Gen. Mark E. Bradley, deputy chief of staff for materiel; Lt. Gen. J. E. Smart, vice commander of Tactical Air Command and Lt. Gen. F. H Griswold, vice commander of Strategic Air Command.

will serve as the channel for all industry contacts with the Air Force on a particular system.

The new AFR 375-1, recognizing the overlap between development and production and the difficulty of drawing a sharp line of demarcation, defines the life cycle of a weapon/support system in terms of three easily identified phases:

- **Conceptual:** While a system's operational requirements are being worked out, and before they have been made final by the publication of a Specific Operational Requirement, the program is under the Deputy Chief of Staff for Operations (DCS/O). When the SOR is published, signaling the end of this phase, a System Staff Office is formed at headquarters and a System Program Office is established in the field.
- **Acquisition:** Development of the system is the responsibility of the Deputy Chief of Staff for Development (DCS/D) and the Air Research and Development Command. Subsequently, responsibility is transferred to the Deputy Chief of Staff for Materiel (DCS/M) and the Air Materiel Command. Where formerly the transfer from ARDC to AMC occurred when the decision to produce for inventory was made, under the new regulations this transfer is to be made "not later than delivery of the first inventory unit or installation to the using command." The transfer can be made earlier if directed by the chief of staff.
- **Operation:** This period starts with delivery of the first inventory or installation to the using command, or the chief of staff can designate that the system has attained operational capability acceptable for the intended mission. The system then becomes the responsibility of the deputy chief of staff for operations and the using command. The acquisition phase often overlaps the operational phase, AFR 375-1 points out.

System Package Program

System Program Offices operating under the new integrated package program will be required to make a very detailed analysis of every aspect of the system, developing schedules, budgets and plans for their particular system. This will include such items as:

- **Intelligence estimate,** as to the environment in which the system is expected to operate.
- **Master schedule,** a composite of individual subsystems and elements, showing major milestones, key events and required actions, and indicating responsible agencies.
- **Budget plan,** containing the status of prior and current year allocated funds and estimates of future fund requirements in summary for all elements of the program by fiscal year through the planned life of the system.
- **Financial plan,** detailing expected utilization of funds during the current fiscal year and a projection of estimated fund use in succeeding years through the planned life of the system.
- **Operational plan,** giving information on mission, tactics, organization, training, ready dates, mobility requirements, operational locations and channels of control and communications.
- **Materiel support plan,** describing materiel support system to be used, from test activities through inventory support phase, in terms of areas of supply, maintenance, transportation and depot, contractor and base resources.
- **Development/test/production plan,** giving quantitative requirements, schedules, research and development approaches, test programs to establish system or subsystem feasibility, performance, reliability, production leadtime, production plans, industrial capability, facilities needed (both industrial and military construction), and cost estimates for all elements of the plan.
- **Personnel plan,** describing numbers and qualifications of personnel needed to operate and maintain the system and an indication of the availability of required personnel.
- **Training plan,** describing requirements and curricula, implementation dates, training aids and facilities, and their estimated cost.
- **Program management plan,** outlining how the program is to be managed, type of contract which will be used, and industry's specific management responsibilities. Any special relationships required between participating agencies also will be shown.

Legislative Lobbying Expenses Detailed

Washington—Statements filed with Congress on receipts and expenditures for legislative lobbying activities for the July-September period, 1960, included:

- **Aerospace Industries Assn.:** receipts, $6,293, and expenditures in the same amount.

Separate statements were filed by AIA officials V. J. Adducci, listing receipts of $3,384 and expenditures of $256, and Harold Mosier, listing receipts of $2,704 and expenditures of $29.

- **Air Transport Assn.:** receipts, $2,243, and expenditures in the same amount.
- **National Counsel Associates,** representing Independent Airlines Assn.: receipts, $1,750, and expenditures, $1,342.
- **Harry S. Baer,** representing National Aeronautical Services Assn.: receipts of $2,500 and no expenditures listed.
- **Scott C. Whitney,** representing American Airlines: receipts of $1,000 and expenditures of $700.

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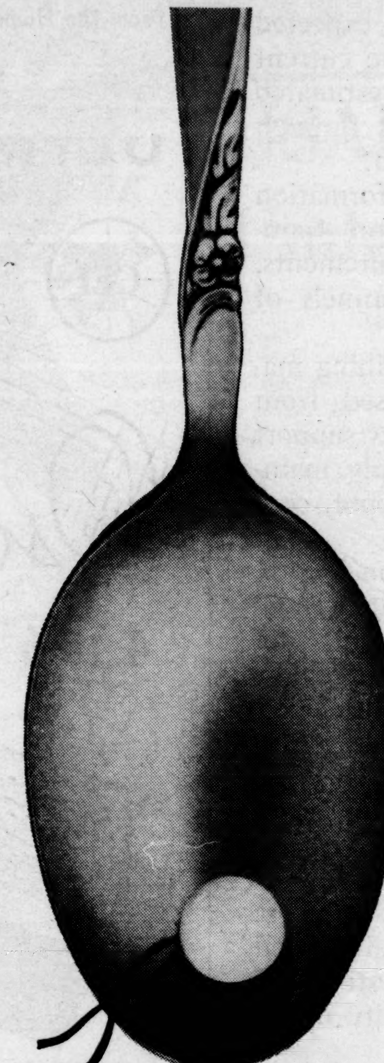

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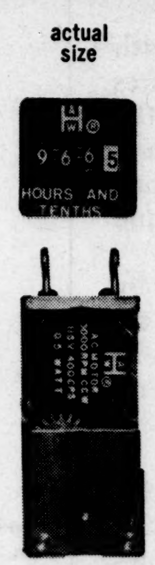

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AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command Aeronautical Systems Center:

Roanwell Corp., New York, headset, electrical, H-154(XA)/AIC, and related data, contract AF-33(600)41957, 50 ea., $38,500.

General Electric Co., West Lynn, Mass.. indicators, rate of flow, totalizing, type MA-7, contractor's P/N 8DJ71GAB-1, FSN 6119-6620-551-2631, Aerno 61-2463, 112 ea.; indicators, rate of flow, fuel totalizing, type MA-8, contractor's P/N 8DJ72GAB-1, FSN 6119-6620-551-1270, Aerno 61-2464, 33 ea.; spare parts, ground support equipment and data, RFP's ES-1-6620-3063, ES-O-6620-7202 and ES-1-6620-3189, contract AF 33 (600)42119, $63,114.

General Electric Co., West Lynn., Mass., transmitters, rate of flow, fuel, type, TRU-6/A, in accordance with specification MIL-T-0026298C, dated Nov. 16, 1959, Aerno 61-2491, IFB 33-600-61-5, contract AF 33(600) 42178, 72 ea., $62,197.

Research, Inc., Minneapolis, Minn., arresting cable, pop-up device, contract AF 33(600)42360, $158,915.

Cincinnati Milling and Grinding Machines, Inc., Cincinnati, Ohio, electrical discharge machining program, contract AF 33(600)42282, $274,986.

Red Bank Division, The Bendix Corp., Eatontown, N. J., inverters, rotary, 250 volt ampere, contractor's P/N MG-62-A, Aerno 42-2318 (Army installations for HU-1B aircraft) and data, IFB 33-600-61-22, contract AF 33(600)42447 dated Nov. 10, 1960, 184 ea., $67,258.

Westinghouse Electric Corp., Dayton, Ohio, generators, a.c., 8 kva. contractor's P/N 904J026-1, FSN 6115-802-8166, Aerno 42-0335, 213 ea.; panels, control, a.c., contractor's P/N 906D075-6, FSN 6110-8815-5127, Aerno 42-0336, 288 ea.; transformers, current, contractor's P/N 906D876-2, FSN 5950-683-7407, Aerno 42-0338, 288 ea., Regulators, voltage, contractor's P/N 727-6338, 288 ea., and related data (installations for T-38A aircraft), contract AF 33 (600)42266, $1,380,915.

Olympic Radio and Television Division, The Siegler Corp., Long Island City, N. Y., amplifiers, synchro signal compass, type ME-1A, Aerno 60-3861, (use: depot replenishment spares), supplemental agreement No. 4, to contract AF 33(600)38755, 1,972 ea., $511,813.

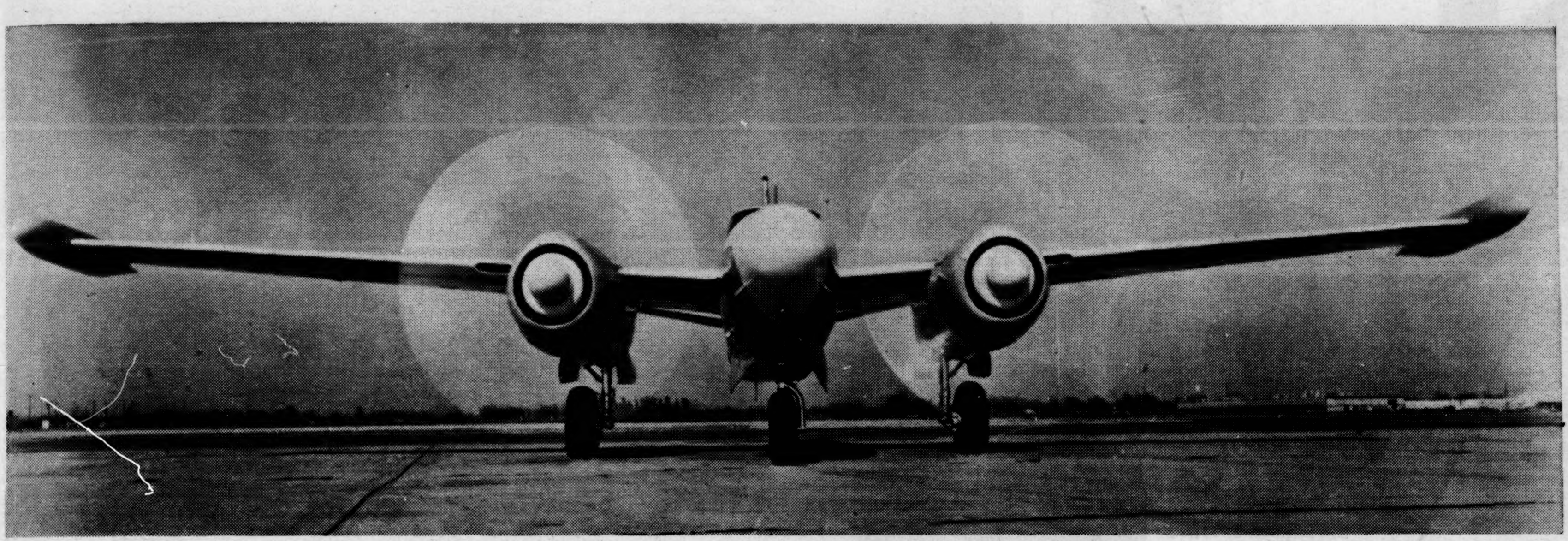
Lewis Engineering Co., Naugatuck, Conn., indicators, temperature, thermocouple, self-balancing potentiometer, type MS24569-2, contractor's P/N 502BL7, Aerno 61-8866 (usage: USAF installations for B-58A) and data, spare parts and ground support equipment,, contract AF 33(600)42454, 80 ea., $67,300.

Collins Radio Co., Cedar Rapids, Iowa, horizontal situation indicators, type AF/A24J1, FSN 6009-6610-633-4260, Aerno 60-6308, 320 ea.; amplifiers, horizontal situation display, FSN 6009-6610-617-0426, Aerno 60-6315, 222 ea. (USAF installations in F-105D) spare parts, ground support equipment and data, contract AF 33(600) 42186, $835,650.

Ewen Knight Corp., East Natick, Mass., parametric amplifier groups for a 2150-2350 mc. telemetry system, six ea.; remote tuning equipment, six sets and related data, contract AF 33(600)42309, $92,332.

Linde Co. Division, Union Carbide Corp., Indianapolis, Ind., converter, liquid oxygen, type GCU-17/A, Aerno 46-0106 (applicable to B-52H aircraft), maintenance and engineering data, IFB 33-600-61-60, contract AF 33(600)42839, 227 ea., $198,284.

Courter Products Division, Model Engineering and Manufacturing Co., Inc., Boyne City, Mich., indicators, pressure, 0-100 psi., type EGU-2/A, Aerno 61-502, (use: installations for T-38A aircraft) spare parts, special tools and test equipment, IFB 33-600-61-76, contract AF 33(600)42435, 587 ea., $35,883.



CLEAN LINES of the On Mark conversion of the Douglas B-26 are shown here. Nose section is of non-reflective plastic to house weather radar antennas. Wing tip tanks, plus 100-gal. outer wing panel tanks, provide for 2,500-mi. range.

Pressurized B-26 Cruises at 365 mph.

By William S. Reed

Van Nuys, Calif.—On Mark Engineering Co.'s newest B-26 conversion, the pressurized Marksman, reflects the engineering and remanufacturing work put into it by cruising at speeds comparable to late model turboprop executive transports costing three times as much.

A follow-on model of previous versions, of which On Mark has turned out more than 40, the Marksman will cruise at 365 mph. at 20,000 ft. and maintain a comfortable cabin environment for five to seven passengers. Range of 2,500 mi. and short field performance are other features On Mark feels enhance the aircraft's value.

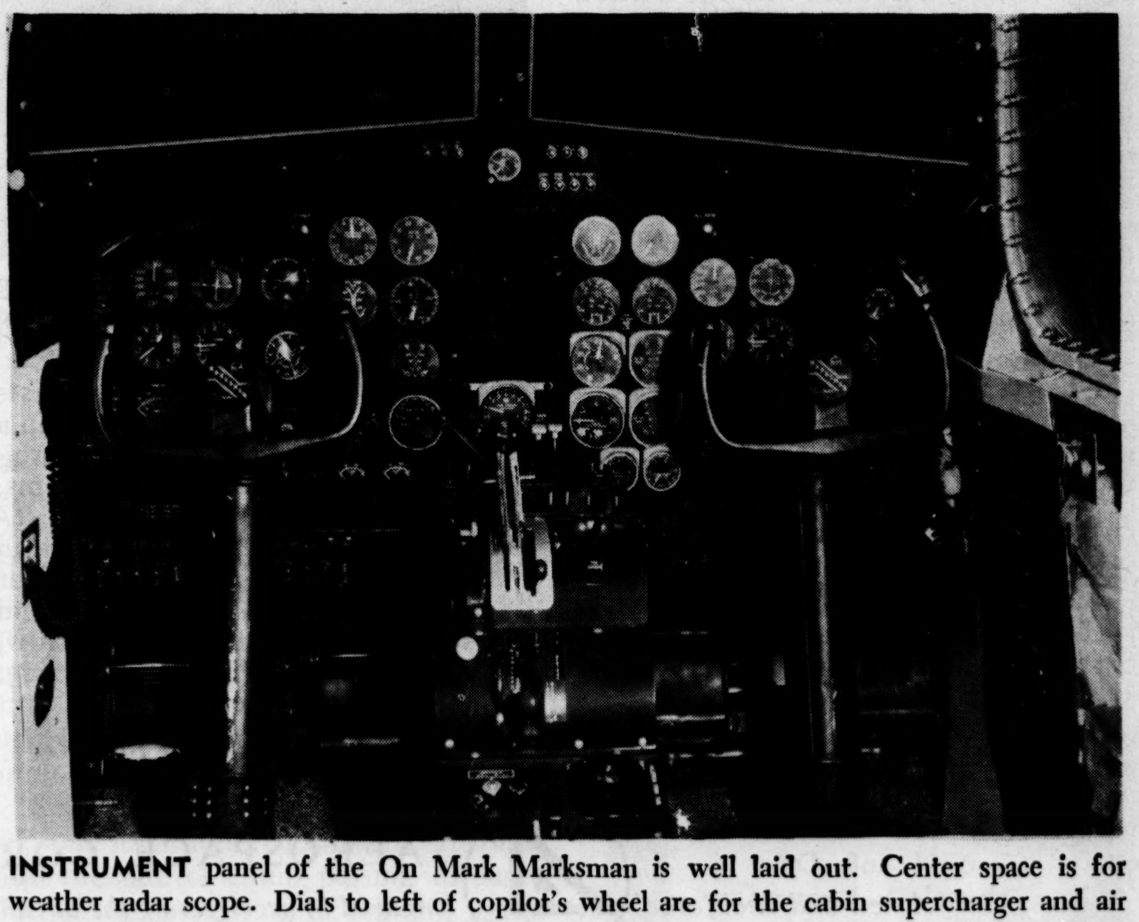
During a recent flight in the Marksman demonstrator, this Aviation Week pilot observed that the engineering changes On Mark has made in the conversion process yield a fast, comfortable executive transport which retains the inherently good flying qualities for which the B-26 is noted. Performance exceeds that of the original Douglas aircraft by a considerable margin, especially the models equipped with Pratt & Whitney R2800 CB-16/17 engines of 2,500 hp. The R2800-75/79 engines developing 2,000 hp., used originally in the B-26, are retained in lower-priced conversions. Stability and control remain good about all three axes with control forces light yet positive. The aircraft leaves little to be desired in the handling qualities for which the B-26 is noted.

One major change is necessitated in the Marksman control system as a result of the 25% increase in available horsepower developed by the CB-16/17 engines. In order for the aircraft to conform to minimum control speed requirement (V_{mc}) during engine out operation, increased rudder area and a geared servo tab are incorporated. This offsets the increased yawing moment due to greater power when approaching V_{mc}. On Mark had the new rudder designed and built before the V_{mc} test was conducted so that when initial flight analysis revealed that added area was needed, the new rudder was ready for installation. Elevator and aileron forces and displacement have not been changed even though a power increase usually is destabilizing.

Considerable effort has been put into rearranging the cockpit while removing combat equipment from the aircraft. Most of the central pedestal has been eliminated permitting easier ingress and egress.

The cockpit display of the demonstrator conforms to standard grouping and instrument size practice and can be installed in any pattern specified by the customer. Engine and propeller installation is similar to the Convair 340 with auto-feather and electrically-actuated prop pitch controls.

On Mark eliminated the cable operated prop governor controls on the Marksman demonstrator but will revert



INSTRUMENT panel of the On Mark Marksman is well laid out. Center space is for weather radar scope. Dials to left of copilot's wheel are for the cabin supercharger and air conditioning system. Lever-operated prop pitch controls will replace toggle switches. Douglas DC-7 windshield of bird-resistant, heated glass replaces the B-26 windscreen.

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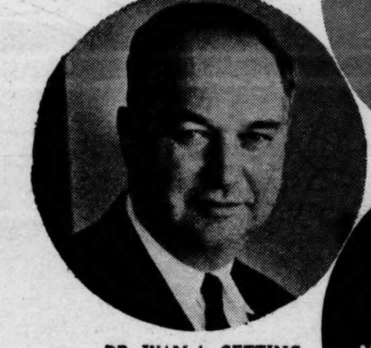
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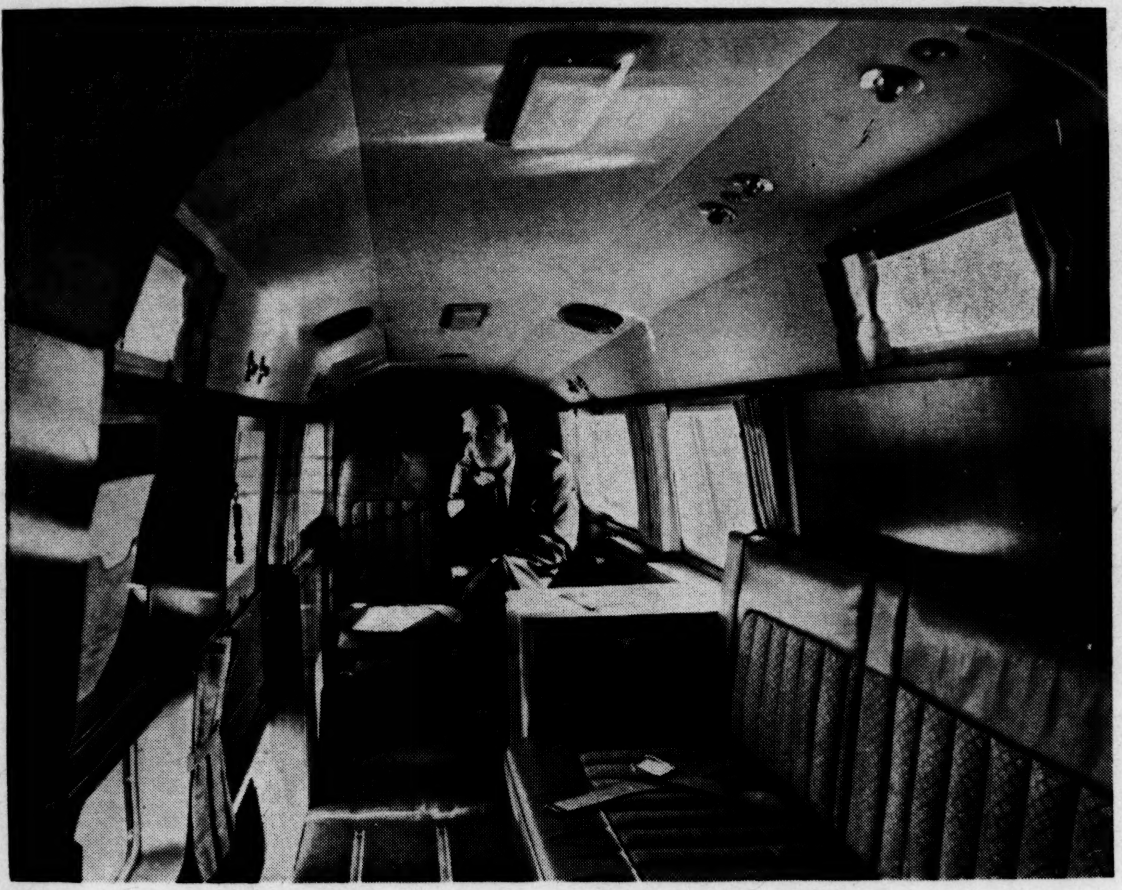
INTERIORS of all Marksman aircraft are custom-finished to the buyer's specification. This five-passenger cabin includes a couch, two chairs, folding desk, air-to-ground telephone, repeater radar scope and instruments. Extra seats can be installed on rails in front of couch.



to these in subsequent aircraft because synchronization is rather difficult.

Dual controls are standard in all On Mark conversions and operation of the aircraft from either seat is possible under all flight conditions. Cockpit visibility is as good or better than that of twin- and four-engine transports although not as good as in the military B-26 because the transparent clamshell hatches have been removed during fuselage remanufacture and pressurization.

Taxiing the Marksman is accomplished in the same manner as conventional B-26s. Visibility is good and ground handling easily accomplished with differential braking and throttle action. Nose wheel steering, either rudder pedal-operated or by a separate fixture on the pilot's control wheel, is offered as an option.

Takeoff in the Marksman demonstrator at 30,500-lb. gross weight, altimeter 30.28 in., elevation 799 ft. and the ambient air temperature at 20C, was accomplished in about 1,300 ft. using full power and anti-detonation injection (ADI). Climb, as the aircraft passed through 3,000 ft. mean sea level, indicated 1,200 fpm. with power setting at 2,400 rpm., manifold pressure at 44 in. Hg., airspeed indicating 225 mph.

Supercharging was shifted to high blower just under 13,000-ft. altitude and the rate of climb passing through 15,000 ft., indicating 220 mph., again was 1,200 fpm. Cruising altitude of 20,500 ft. was reached approximately

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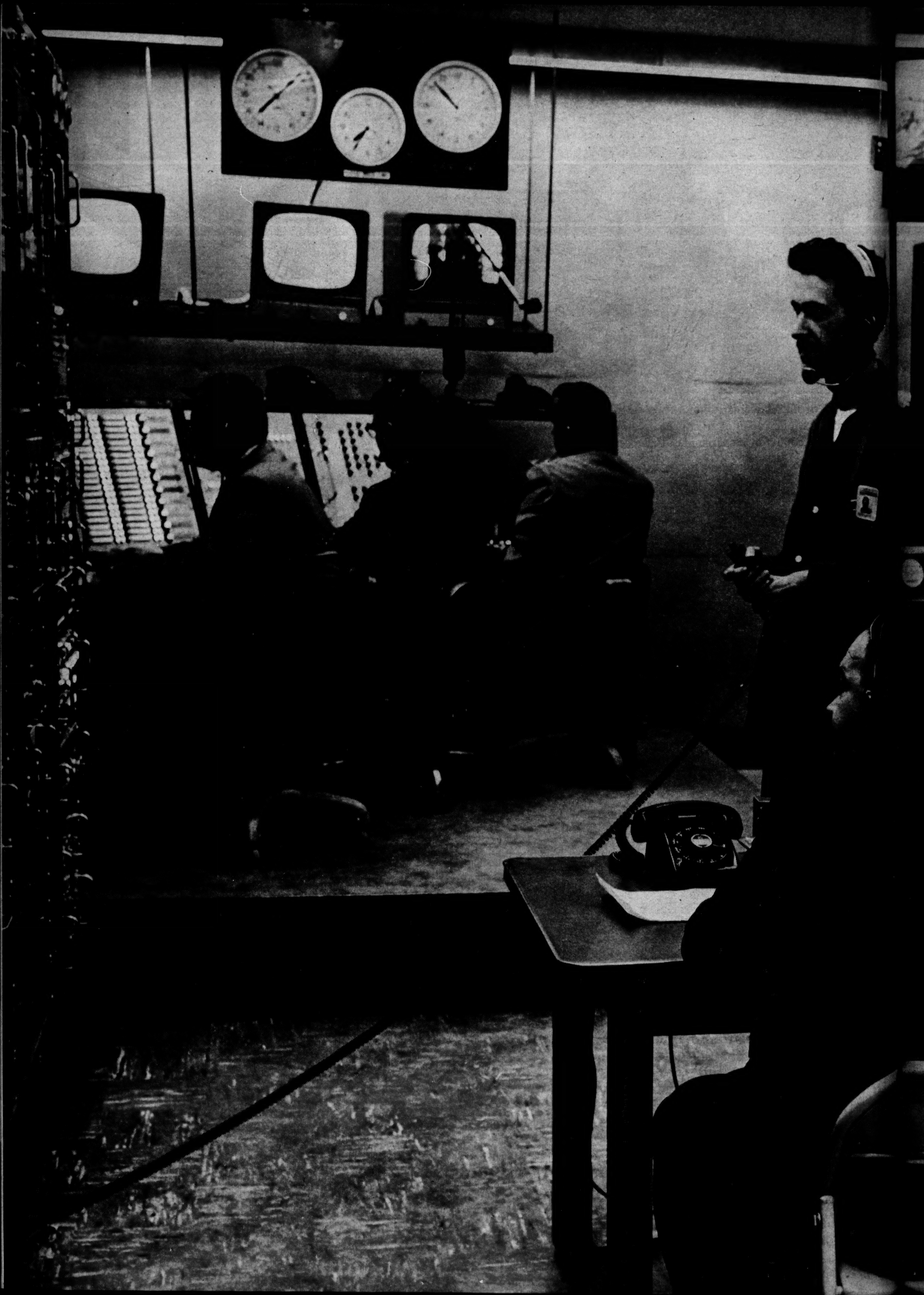

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16 min. after takeoff and the aircraft allowed to accelerate to best speed before power was reduced from climb to cruise.

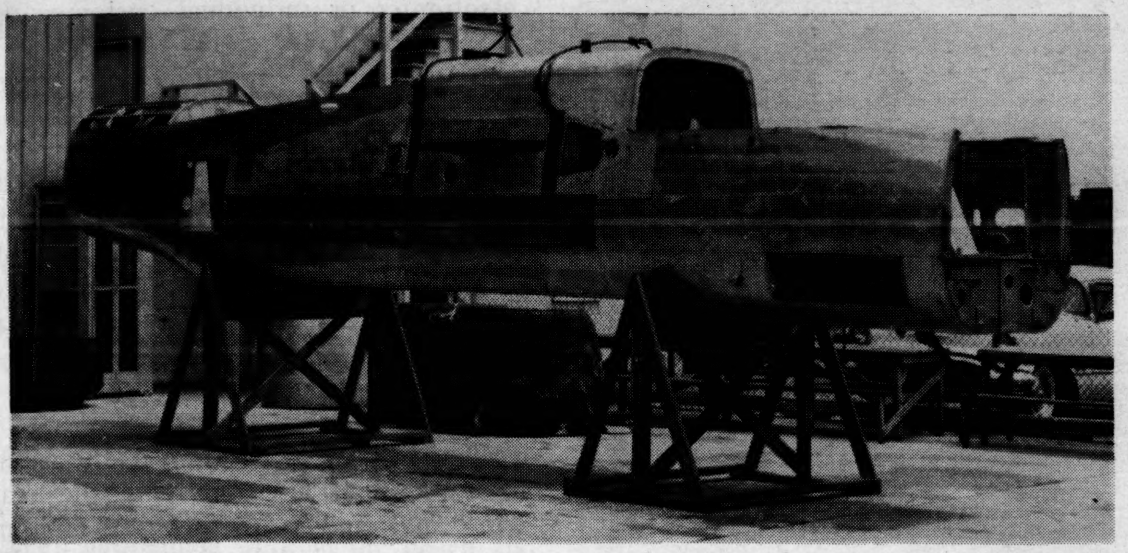
Full manifold pressure, as specified in the P&W handbook, could not be reached on this flight because the atmosphere was considerably above standard. Free air temperature was −10C rather than the −28C expected on a standard day. The Marksman reached a stabilized IAS of 255 mph. which yielded approximately 350 mph. true airspeed. Had the temperature been nearer to standard, the aircraft would have reached or exceeded the 365 mph. TAS which On Mark chief pilot J. H. Siberell predicted. Fuel flow at cruise indicated between 95 and 100 gph. in auto lean. Cabin altitude held at a constant 8,000 ft. and cabin temperature was varied from time to time to establish that any desired temperature could be selected and automatically maintained.

During descent, cabin rate of change was maintained automatically at a preset 400 fpm. despite variation in the aircraft rate of descent from 1,500 fpm. to 2,000 fpm.

Landing is accomplished in the manner of standard B-26 aircraft. The pattern is flown with 20 deg. of flaps down, gear extended and airspeed at about 140 IAS. Control is positive and comfortable at this airspeed. Full flaps are lowered on the final approach and the airspeed held between 120 and 130 depending on gross weight. Although a moderate amount of reverse thrust was applied on landing, no attempt was made to determine minimum distance to stop. On Mark specifies a 1,700-ft. ground roll to full stop at 30,000 lb. gross weight and with optional anti-skid brakes, the aircraft can be stopped in 1,290 ft. This can be cut to less than 1,000 ft. with the additional use of reverse thrust.

On Mark conversions are licensed under a Supplemental Type Certificate (STC) issued in accordance with Part 9 of the Civil Air Regulations. Licensing is dependent upon the licensee demonstrating to the Federal Aviation Agency that rework on the airframe has not resulted in any decay of performance or stability and control.

Since the Marksman and earlier versions are STC Category aircraft, On Mark cannot guarantee or advertise performance except that which is listed in the military handbook for the aircraft, Technical Order AN 01-40AJ-1, dated 29 March 1951. Removal of gun turrets, armor plate, bombing equipment, bomb-bay doors and actuators and other combat equipment has considerably cleaned up the aircraft aerodynamically and greatly reduced the empty weight even with plush interiors. Therefore, the Marksman enjoys the



EXTENT to which the Douglas B-26 fuselage is dismantled is shown by this photo of one body from which unusable portions have been removed. Complete cockpit and windshield will be added, a new nose built on, fuselage aft of the wing will be recontoured and entrance door installed. Rear wing spar is removed and replaced by a steel circumferential bulkhead.

same maximum allowable gross weight as the B-26,–35,000 lb.–much more than is needed for even maximum range operation.

Performance also exceeds that of the military B-26 by a wide margin because of aerodynamic cleanliness, reduced weight and in the case of the Specification C aircraft with R2800 CB 16/17 engines, a 25% increase in horsepower.

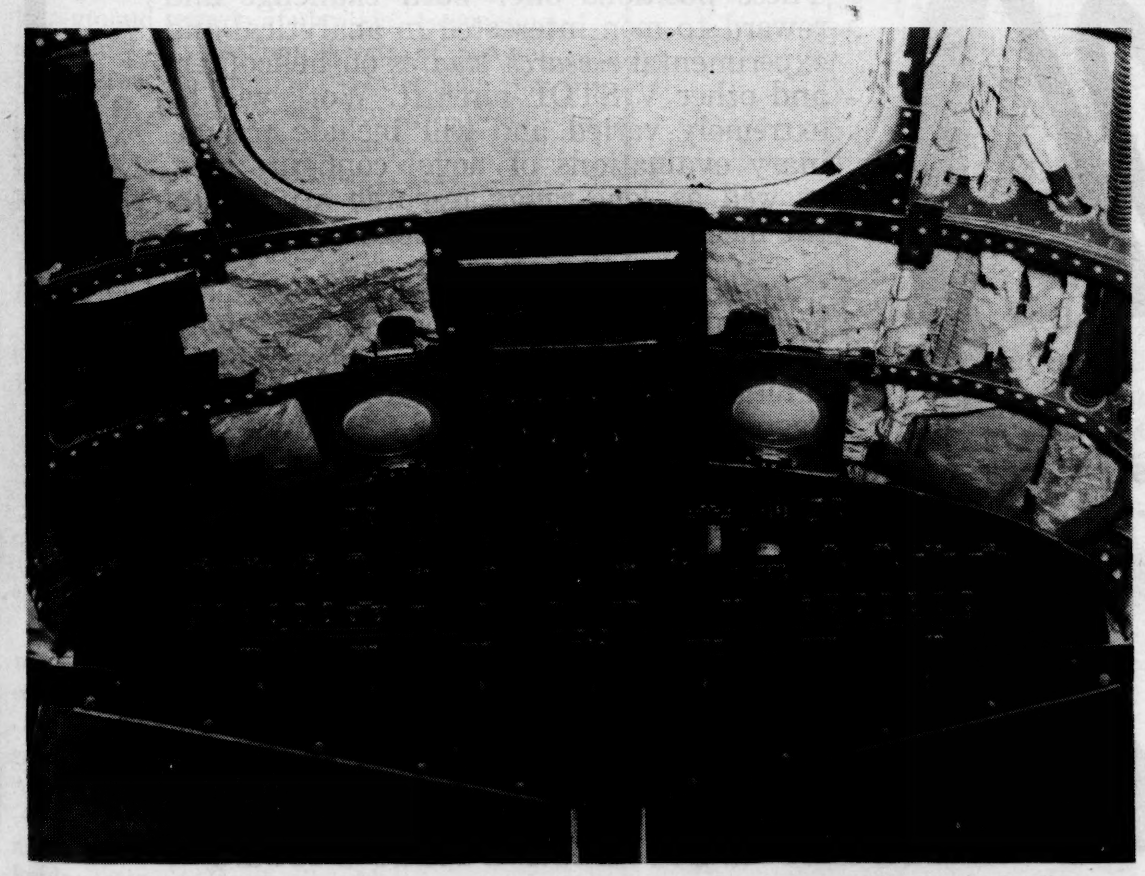
First pressurized Marksman On Mark has sold will be delivered in February and now is in the process of custom interior installation. Amount of electronic gear, interior arrangement, paint scheme and even the extent of the conversion, is left to the customer and is performed by the company for a fixed price established before conversion starts.

Standard conversion under Specification A, priced at $257,000, includes a completely remanufactured, pressurized, air-conditioned fuselage (On Mark estimates that the fuselage is 85% new), new nose section with bird resistant, heated windshield and enclosed canopy, Pratt & Whitney R2800-75/79 engines with less than 350-hr. dual controls, new instrument panel, oxygen system, prop and carburetor anti-icing, fire detection and extinguishing system, cabin heaters, electrical system plus interior and exterior finishing.

Specification B includes all the above in addition to zero-time engines, new high-activity propellers, 165-gal. wing tip tanks plus DC-6 type wheels and brakes with chrome-plated landing gear. Price is $314,475.

Specification C features zero-time R2800 CB-16/17 engines, reversing props, and two 100-gal. Pliocell tanks in the outer wing panels. Price is $361,492.

Quoted costs do not include radio,



OVERHEAD PANEL contains an emergency escape hatch because clamshell hatches are removed and the cockpit enclosure skinned over.

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Standard fuel capacity of the Specification A aircraft is 800 gal., offering a range of 1,200 stat. mi. Fuel capacity increases to 1,130 gal., range to 1,800 mi. with tip tanks in Specification B aircraft and the addition of 100-gal. outer wing tanks increases capacity to 1,330 gal., range up to 2,500 mi. in the C aircraft.

Space Provided

On Mark provides room in the cabin of the aircraft by removing the rear wing spar and substituting a circumferential ring bulkhead to which the wings are mounted in the same place as with the carry-through spar. Forward spar is not changed because of the magnitude of re-engineering required and crew members therefore are left with the inconvenience of mounting the flight deck through a crawlway along the right side of the cabin beneath the spar.

On Mark engineering is licensed by Douglas Aircraft Co. for the manufacture and sale of parts for B-26 aircraft and has obtained all necessary tooling for providing spares. On Mark also has purchased several surplus B-26s which are stored on their premises awaiting conversion as orders are placed.

Swathmaster Adapted for Grumman Ag-Cat

Transland Aircraft has adapted its Swathmaster chemical dispenser for installation on the Grumman Ag-Cat, following a series of flight and operational tests by Jim French, operator of Farmers Crop Dusters, Bakersfield, Calif., using both Continental 220-hp. and 450-hp. powerplants in the airplane. Light-powered Ag-Cat can handle 1,600-lb. payloads and 450-hp. plane can haul 2,100 lb. Swathmaster weighs 87 lb., about 30 lb. lighter than original model. New unit was developed for Transland by its inventor, Joe Sellers. It has been used in some applications by Piper PA-18A and Pawnee operators.

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RESEARCH LABORATORIES
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WHO'S WHERE

(*Continued from page 19*)

Honors and Elections

Lt. Col. Thomas H. Miller, USMC, and **Cdr. John F. Davis**, USN, who set two closed course records in September on individual McDonnell F4H-1 flights, have received the General Electric Trophy.

Roger L. Easton and **Martin J. Votaw** of the U. S. Naval Research Laboratory have received the 1960 Institute of Radio Engineers Professional Group on Reliability & Quality Control Award in recognition of their "outstanding work in the design and development of the radio transmitter in the Earth Satellite, Vanguard I."

Phillip L. Gundy, senior vice president of Ampex Corp., has been elected president of the Western Electronic Manufacturers Assn. Elected vice presidents: **Arthur N. Curtiss**, general manager of the RCA West Coast Missile and Surface Radar Division; **Kenneth C. Stone**, president of Kinetics Corp.; **William C. Webber**, vice president of Tektronix, Inc.

Changes

Warren W. White, assistant director of engineering, Robertshaw-Fulton's Aeronautical and Instrument Division, Anaheim.

Eugene N. Torgow, chief engineer, Dorne and Margolin, Inc., Westbury, N. Y.

James R. Greenwood, manager-press relations, and **R. James Yarnell**, manager-advertising, Beech Aircraft Corp., Wichita, Kan.

Dr. Harold V. Hance, associate director and a senior scientist, Systems Research Center, Lockheed Electronics Co., Bedminster, N. J.

Charles J. White, ground power sales coordinator of the newly established Ground Support Organization, General Electric Co.'s Aviation and Defense Equipment Sales Operation, Washington, and **James W. Scanlan**, ground power application engineering manager, GE's Aviation Electrical Systems Engineering Sub-Section, Waynesboro, Va.

John H. Boyle, general manager, Collins Radio Co.'s new Communication and Data Processing Division, Dallas, Tex. Also: **Richard F. Haglund**, general manager of Collins' new Service Division, Cedar Rapids, Iowa, and **Robert C. Terbeck**, director of field services.

Dr. George Wertwijn, director of engineering, Evanston (Ill.) plant of Hoffman Electronics Corp.'s Semiconductor Division.

Charles K. Titus, manager, Scientific Analysis and Programing Department, Collins Radio Co., Cedar Rapids, Iowa.

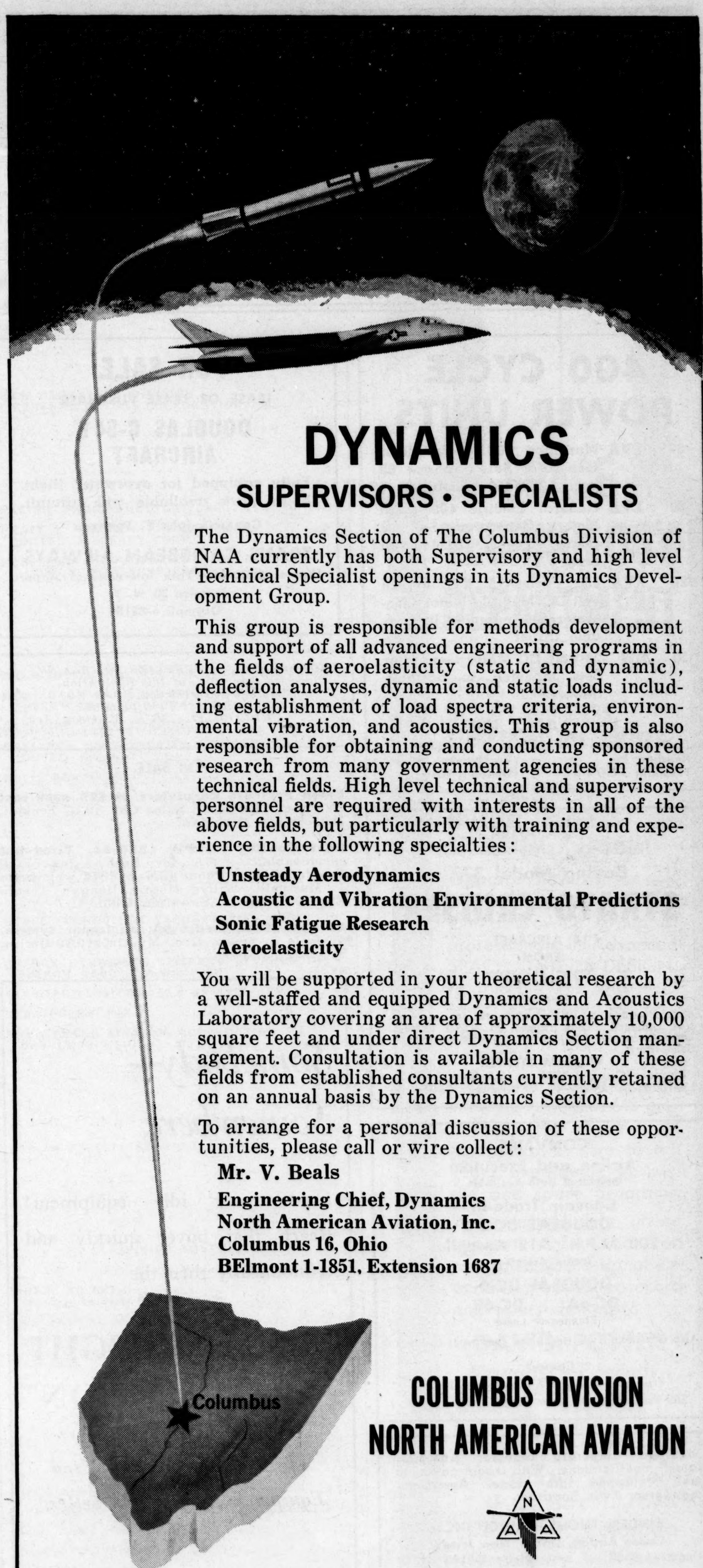
Capt. William E. Kenna (USN, ret.), assistant quality control manager, Sikorsky Aircraft Division of United Aircraft Corp., Stratford, Conn.

Arthur R. J. Johnson, customer services manager, Systems Division of Beckman Instruments, Inc., Anaheim, Calif.

Jack Gillette, associate director of engineering, Standard Rectifier Corp., Santa Ana, Calif.

T. Bruce Cooper, manager-southeast military area for Beech Aircraft Corp., with headquarters in Huntsville, Ala.

Robert V. Esposito, corporate planner, Lockheed Electronics Co., Plainfield, N. J.



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LETTERS

Avionics Coverage

I believe credit should be paid where it is due and your magazine deserves commendation for its prompt, accurate, reliable and vivid reporting on matters concerning aviation and its technical aspects. As an electronics engineer, I have been following technical magazines by the dozens for just as many years and I am happy to say that if I read Aviation Week and one other magazine I am as well or better informed than by reading the many other magazines which apparently get much of their information second hand. I am particularly impressed with the quality of your reporting in my special field—electronics. I wish you lots of luck in continuing your fine editorial policies.

Rudy C. Stiefel
New York, N. Y.

Airship Advocate

Your editorial (AW Dec. 19, p. 21) urging mobile airborne missile platforms raises once again that perennial question concerning the role that modernized structural or Zeppelin type airships might play in today's military scheme of things.

Dirigibles are—to say the least—controversial subjects. Yet a helium-inflated super-Hindenburg type would possess these unmistakable advantages: (1) a peculiar suitability, due to low power and shielding requirements, to nuclear propulsion; (2) a useful military, that is, missile payload of at least 50 tons; and (3) an on-station unrefueled endurance of about one week with conventional fuels and two months (crew endurance permitting) if nuclear powered.

As a "loitering aircraft," such vehicles could patrol and operate in ice-covered and land-locked areas currently "out of bounds" to Polaris submarines. Dr. Hugo Eckener, the most successful of all airship operators, predicted in the late 1940's that one of the most attractive regions for Zeppelin airship operations would prove to be the Arctic. In his opinion—second to none in the lighter-than-air field—there would be little hazard from icing and weather.

Admittedly the large slow-moving dirigible is vulnerable. But in these days of nuclear warheads, vulnerability is universal. The airship is no more vulnerable than a carrier and not too much more than an airplane. To be vulnerable, however, it has to be found and an ALBM-carrying airship hovering near icebergs or hugging the surface of the polar pack might be much more elusive to radar, IR, and visual detection than commonly supposed.

I do not propose that this country immediately begin a program of airship construction. But I do think that the dirigible's potential as a complement or back-up to our missile capability, fixed, mobile, or underwater, should be adequately investigated while Zeppelin airship personnel with sufficient experience—the key to lighter-than-air success—still remain.

J. Gordon Vaeth
Reflectione Electronics, Inc.
Washington, D. C.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Mercury Viewports

May I expand on your reports in the Dec. 26 (p. 16) and Jan. 2 (p. 21) issues about the viewports on the Mercury spacecraft that was flown Dec. 19? The reports mentioned damage and said the windows consisted of three layers of glass.

Each viewport on this capsule consisted of five panels. They are not laminated. The outer three panels, made of 96% silica glass (Vycor), served as heat shields. The inner two panels, made of strengthened aluminosilicate glass, were designed to meet a double fail-safe requirement to protect the integrity of the enclosure. Since the outer panels were designed to survive launch forces and reentry temperature only, we were not concerned that one, two or all three of these outer panels might break from the impact of landing. In fact, the frame was designed for this possibility. Since only the outer-most panel on one viewport broke Dec. 19, we are satisfied that the viewpoints functioned exactly as designed.

I might mention that a later viewport design, trapezoidal in shape rather than circular, consists of four panels—two heat-shielding Vycor panels and two strengthened aluminosilicate panels. Purpose of this design is to provide more viewing area. Some Mercury spacecraft already are equipped with the new viewports.

A. F. Shoemaker
Product Development Coordinator
Aircraft & Missiles Group
New Products Division
Corning Glass Works
Corning, N. Y.

JATO in Emergency

The circumstances of the tragic crash of a twin-engined transport in downtown Munich, Germany, have led me to the following question:

Why don't all civilian and military transport aircraft carry JATO (auxiliary "canned" jet power) to be used in emergencies, such as a partial power failure immediately after takeoff?

The ill-fated plane out of Munich had engine trouble almost immediately after takeoff. Perhaps a few seconds of extra thrust given by JATO equipment could have helped return the aircraft to the two-mile-distant airport or enabled it to reach the empty field of the Munich fair grounds.

C. L. Marshall
Haynes Stellite Co.
Division of Union Carbide Corp.
New York, N. Y.

Education Funds

Concerning Dr. Killian's views on space programs (AW Dec. 19, p. 29), it is pertinent to remember we have spent approximately 400 billion dollars on defense (with much interservice attempted duplication such as the P6M failure to compete with the B-52). We have spent a few billions on space. Decisions on how much we spend on these categories are dependent on how much the Russians spend on like categories.

The sooner we start matching the Russian's efforts in education the better off we will be.

The sensible thing to do, of course, is for Russia and the United States to cut their defense spending to say 10 billion dollars each and limit their space effort to a like amount. This would leave a nice round sum of 20 billion per year for education.

C. W. Crabb
Washington, D. C.

Collision Chances

The F-86L-Bonanza collision analysis in your Dec. 19 issue (p. 95) was presented very well. It is just another illustration of the impossibility of "seeing and being seen."

For many years I have been of the opinion that the only reason there are so few air collisions is due to simple percentages of few airplanes being in the same airspace at the same time. When you have different speeds, 360 deg. of converging courses plus climb, descent and course changes, there are many more chances of collision than chances of avoiding collisions. The F-86 had possibly 10 sec. to observe the Bonanza, but if he was in a descent during those last seconds there would have been no margin for avoidance.

Some years ago while Chief Justice Warren was Governor of California, his Twin Beech was involved in a collision near Santa Monica. In this case there were no injuries, luckily. Of four people in the two airplanes, only Mrs. Warren, a passenger, was aware that possibly a collision had occurred. Governor Warren's ship had taken off from Los Angeles International and was climbing on (VFR) course to Newhall LF range. The other ship, an Ercoupe, was descending at less than 300 fpm. to enter the Santa Monica pattern. The Beech vertical antenna cut two-thirds through the Ercoupe's fuselage, back of the seat and ahead of the elevator. Neither pilot was even aware of a bump, but Mrs. Warren had observed the Ercoupe at very close range.

Here were two good pilots in good visibility in no extreme maneuvers. The FAA should be made to understand that the "see and be seen" philosophy is nonsense, that much more control is needed for any altitude changes at any time until a satisfactory anti-collision warning system is perfected.

W. L. Martindale
Beverly Hills, Calif.